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Reform of R&D Management System in Defense Sector

40080096a Beijing ZHONGGUO KEJI LUNTAN [FORUM ON SCIENCE AND TECHNOLOGY IN CHINA] in Chinese No 1, 1988 pp 16-18

[Article by Gong Wei [7895 5898]: "National Defense S&T System Reform Should Be More Extensive"]

[Text] Since the Third Plenum of the 11th PCP Central Committee, several readjustments and reforms have been carried out in the national defense S&T system following the extensive development of S&T system reforms and a strategic shift in national defense construction, and under guidance by the principles of civilian/military integration and peacetime/wartime integration. These reforms included: on the basis of strategic policymaking by central authorities, clarification of the guiding ideology in national defense S&T work of orienting toward the four modernizations drive and serving national defense construction and construction of the national economy; implementation of the principle of "reducing battlelines, focusing on key topics, grasping scientific research, accelerating renewal" in weapons and equipment development; reforming fund allocation and management methods for national defense scientific research and trial manufacture, and implementing a contract system under state mandatory plans; deploying and readjusting national defense scientific research capabilities; developing many types of horizontal linkages; improving macro and micro management of scientific research, and reinforcing the vitality of scientific research units. Readjustment and reform have promoted military/civilian integration, developed many new types of weapons and equipment, and produced new developments in national defense S&T. At the same time, gratifying achievements have been made in readjusting the corresponding scientific research capabilities and active participation in civilian product development. In 1986, the value of output of civilian products in military industry departments accounted for 63 percent of their gross value of output. They have achieved a historical transition from the dominance of military items to dominance of civilian items in their product mix. As technology markets have grown, national defense S&T have shifted continually into civilian uses. This has promoted development of the national economy and stable growth in foreign trade and exports, and it has become a pillar industry in China's export foreign exchange earnings. However, because the national defense S&T industry was in a long-term state of being on the brink of war and being isolated, many problems accumulated. It would appear that the reform measures accomplished are merely the initial stage of the overall process, so we must summarize experiences in practice, perfect and enrich them, and continue to intensify them. As a result, readjustment and reform tasks in the national defense S&T system still will be rather difficult.

I. Start With Reality, Accelerate Readjustment in National Defense Scientific Research Capabilities Based on the Principle "Smaller Spread, Higher Standards"

The main problem in the national defense S&T industry at present is that military product scientific research and production are too spread out, scattered, and repetitive, and greatly exceed the needs of peacetime national defense construction. The state should concentrate forces for economic construction. Funds for national defense scientific research are limited and cannot be spread too wide. Investment intensity is very low and standards are hard to raise. Thus, national defense scientific research capabilities should start with reality and accelerate readjustment.

First, there must be a firm decision to reduce the overall scale of national defense scientific research capabilities and achieve a smaller spread. In addition, there must be corresponding readjustments in scientific research organization, personnel structures, fund distribution ratios for all stages of national defense scientific research, and other areas to increase investment intensity and produce the maximum benefits under existing conditions to raise standards. This would guarantee smooth achievement of medium and long-term national defense scientific research plans, high-tech plans, the corresponding industrial development plans, andother tasks.

After readjustment of national defense scientific research capabilities, the corresponding administrative and government departments should implement industrial management for scientific research units with primary responsibility for military product tasks and use a contract system under state directive plans to arrange for military product scientific research tasks. For scientific research units with primary or total responsibility for civilian product development tasks, the state should make unified plans, clarify directions and tasks, and bring them into the orbit of development of the national economy. All developmental scientific research units should integrate scientific research with production. Under the principle of voluntarism and mutual benefit, some can enter large and medium-sized enterprises or enterprise groups. Some can become industry development centers. Others can become leading enterprises, and so on, to organize various types of integrated scientific research and production bodies. Administrative departments should provide active guidance and promote their development.

II. Intensify Reforms in National Defense Scientific Research Operational Mechanisms, Perfect Contract Systems Under State Mandatory Planning

A contract system for weapons and equipment development and new fund allocation methods are important reforms in national defense scientific research operational mechanisms. They require stronger survey research, continued intensification, and perfection during practice. The questions which must be further clarified and resolved are:

1. Administrative expenditures and material guarantees for contract implementation are incomplete and lack unity. At present, military user departments as partner A in a contract can only guarantee funds for weapons and equipment trial manufacture. The capital construction, technical transformation, materials and other main guarantees needed for contract implementation must be guaranteed in

department plans, and it is hard to synchronize and coordinate the two. This often makes it impossible to provide full guarantees for contract implementation conditions, and it makes irrational administrative interference hard to avoid. In the future, during reforms in planning, investment, and materials systems, the administrative expenditures required for contract implementation (scientific research and trial manufacture funds, capital construction and technical transformation investments), and materials guarantee conditions should be unified and guaranteed.

2. Scientifically and rationally determine contract cost questions. Because of the effects of the perennial "iron rice bowl" and "supply system" management system, national defense scientific research has never had a strict cost accounting system or scientific accounting methods. As a result, the contradictions have been rather prominent in signing development contracts and they have been delayed for a long time. Accounting and investigation also are difficult. There must be stronger survey research during practice in the reforms and national defense scientific research cost accounting methods should be formulated as quickly as possible to increase the benefits from national defense scientific research.

3. Deal correctly with the relationship between selecting sites and seeking bids. To adhere to the state's principle concerning the need for key S&T projects to work actively in trial implementation of social public bidding and selection of optimum contracting units, we should support trial implementation of bidding in weapons and equipment development projects which have the conditions to seeking bids. However, given the technical complexity of weapons and equipment development, the characteristics of broad cooperation, and the fixed sites and the situation in the division of labor and cooperation formed through history, seeking bids can only be done on a limited scale at present. We must begin with overall economic benefits and the ability to guarantee smooth implementation of the contract system under assigned plans. Consideration must be given to continuity in development tasks and existing material and technical foundations for comprehensive evaluation and selection of the best bidding units, and we must overcome irrational departmental administrative interference stemming from selfish departmentalism.

III. Implement Goal Management in National Defense Scientific Research, Gradually Integrate Programming, Planning, and Budgeting

In a situation of extensive reforms in national economic and S&T systems and gradual implementation of industrial management in national defense industrial departments, departmental management from top to bottom in military product scientific research management should shift to goal management focused on increasing returns to investments to adapt to the situation and demands of national reforms, promote a shift in national defense S&T industry strategies, and establish new systems for military/civilian integration.

The state makes policy decisions, invests, and organizes the development and production of weapons and equipment, and it purchases and distributes them for use, so we should continue to implement state mandatory planning for the related development tasks. Departments and units which assume responsibility for tasks must assure completion of plan requirements. The state should guarantee the necessary conditions for task completion.

To unify the tasks and conditions, we must gradually unify national defense scientific research programming, planning, and budgeting. There should be unified arrangements for development task, scientific research, and trial development funds as well as for investments in capital construction and technical transformation so that conditions keep up with tasks. First, transform present methods of absolutely no change in 5-year plans by making timely readjustments and revisions within the state's 5-year administrative funding control indices on the basis of plan implementation conditions and changes in annual appropriations forecasts. Second, formulate annual plans in strict accordance with stage control indices for administrative expenditures allocated by the state to national defense scientific research and annual allocation indices. Expenditure management should change the existing method of horizontal stripping and slicing and gradually achieve project and task distribution indices and appropriations, basic equilibrium, provide room to move, and eliminate defects.

Capital construction and technical transformation investments and the primary materials and raw materials required for national defense scientific research at present still should be guaranteed through existing systems and channels. In the future, capital construction and technical transformation investments and national defense scientific research expenditures should be interlinked gradually during reforms for unified planning arrangements.

IV. Formulate Policies To Encourage and Develop National Defense Scientific Research On the Basis of Economic and S&T Development Laws and the Characteristics of Military Products

National defense scientific research and production are needed for national safety, and the goal is not to make a profit within China. To strengthen the vitality of scientific research units and motivate their initiative to take on military product tasks, state-assigned military product plans also should work according to economic laws and link the completion of military product tasks with the interests of scientific research units and their employees, provide the necessary guarantees in administrative expenditures, materials, and other conditions, and provide suitable preferences in policies and treatment. Since many national defense scientific research units are located in third-line frontier regions, per capita levels of administrative expenditures are rather low and civilian product development still involves a rather long process, so it will be hard to achieve economic independence in the short run. We feel that there should be no reductions for the time being in administrative expenditures for scientific research units which focus on national defense scientific research tasks or personnel involved in national defense scientific research tasks to facilitate stability in the personnel involved in military product scientific research. In addition, there should be unified allocations for the incomes and awards allocated to scientific research units engaged in national defense scientific research tasks and civilian product development on the basis of the relevant decisions by the State Council, and the awards and incomes of personnel engaged in military and civilian product scientific research should be held for the most part at similar levels. When signing contracts for weapons and equipment development, contract stipulations regarding retention of surpluses should be observed to provide scientific research personnel with suitable rewards.

V. Foster the Glorious Tradition of the Military Industry, Reinforce Construction of National Defense Scientific Research Ranks

National defense S&T industry construction and development since the nation was founded have produced national defense scientific research ranks on a substantial scale which have definite levels and superior working styles. They are concerned not with fame or personal interest but bury themselves in their work and struggle hard to make important contributions to building national defense modernization in China. The main problems now are irrational organizational and personnel structures, the outdated knowledge of personnel, and the lack of people to follow. Specialized personnel account for only 12.6 percent of all employees in the national defense industry in China (this figure is about 50 percent in the developed nations). It has been predicted that specialized personnel in the 40 to 50 age range will decline by one-third by the 1990's compared with today, so we lack key technical staffs to take their places. Since the age of university graduates assigned to work in military industry units has dropped every year for the past few years, there also are no guarantees of quality. If measures are not adopted quickly to deal with this situation, it will be hard to complete the difficult task of raising scientific and technical levels, and there will be a gradual erosion in the relative superiority of military industry personnel. Thus, we must focus on formulating countermeasures and training personnel.

First, we must formulate personnel training, supplementation, updating, and circulation plans and the corresponding policy measures on the basis of development strategies and medium and long-term plan goals and tasks. We must focus on education in institutions of higher education in the national defense S&T industry system, increase investments in education, make good educational reforms, and integrate education, production, and scientific research. We must create conditions and establish systems to provide S&T personnel with opportunities for continued growth and renewal of their knowledge.

We must reinforce the concept of national defense and do propaganda and education on the glorious traditions of the military industry to encourage S&T personnel to dedicate themselves to the cause of national defense S&T. To solve problems of temporary shortages of national defense S&T personnel, we should make appropriate extensions in the age restrictions on older key S&T personnel and accelerate the training of middle-aged and young S&T personnel to make them skilled workers as quickly as possible. There should be suitable improvements in the work treatment of S&T personnel working in frontier regions, stipulations on the age limits in frontier regions, and so on.

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Increasing Science and Technology Input of Industrial Enteprises

40080096b Beijing ZHONGGUO KEJI LUNTAN [FORUM ON SCIENCE AND TECHNOLOGY IN CHINA] in Chinese No 1, 1988 pp 26-27

[Article by Fu Feng]2105 7364]: "Increase S&T Input in Industrial Enterprises"]

[Text] Scientific and technical progress in industrial enterprises is the pillar of development of the national economy. The reason is that large numbers of S&T achievements must move continually into industrial enterprises to form enormous forces of production. This was acknowledge only after the Third Plenum of the 11th CPC Central Committee and after we summarized construction experiences over several decades. During the Sixth 5-Year Plan, economic work in China made gratifying steps in relying on S&T progress. We spent over $10 billion to import more than 14,000 new technologies. Some have attained international levels of the late 1970's and early 1980's. They have played a very good role in transforming the situation in China's enterprises, improving product competitiveness, and reinforcing development reserve strength. This does not mean, however, that the mechanisms for China's enterprises to rely on progress in S&T have taken shape. At present, China's enterprises, particularly medium and large-scale key enterprises, still lack the motivation and vitality to rely on and apply S&T achievements. There are many reasons for this, but one aspect of state investment policies, the lack of corresponding S&T inputs in industrial enterprises, is an important reason.

I. The Current Situation in S&T Input in China's Industrial Enterprises

1. Total administrative expenditures for technology input in enterprises. This refers to the sum of the four enterprise expenditure components of technical transformation, technical development, technology imports, and purchasing Chinese technical achievements. According to 1985 statistics, expenditures in these four areas accounted for 58.62, 21.79, 19.21, and 0.38 percent, respectively, of total enterprise expenditures on technology inputs. This shows that most expenditures on technology input in enterprises are used for technical transformation in enterprises as well as for the goal of expanded reproduction. However, actual expenditures on technical development accounted for only about one-fifth of total expenditures, which really is too small.

2. Enterprise technical development expenditures. The primary sources of enterprise funds for technical development are state appropriations, bank loans, money raised by the enterprises themselves, and so on. According to 1985 statistics, appropriations account for over one-half of expenditures on technical development, while enterprises raise about 30 percent themselves. Enterprise technical development expenditures are used mainly for new product development, technical innovation, improving production conditions, and so on. These expenditures account for about 0.32 to 0.86 percent of the total volume of product sales. The figure for Japan was 2.47 percent in 1982 and 3.65 percent in the United States in 1980, so we are about 10 times behind everyone else.

3. Enterprise expenditures to develop new products. According to 1986 statistics from the State Statistics Bureau, enterprise expenditures for new product development accounted for only about 0.12 percent of the total volume of product sales. In addition, a statistical survey of 6,943 large and medium-sized enterprises throughout China indicated that expenditures for new product development in these enterprises amounted to only 0.32 percent of the total volume of new product sales. In comparison, this proportion is 3.18 percent in the United States. This sort of situation shows that short-term behavior remains a rather serious problem in many of China's enterprises and that they still do not pay adequate attention to new product development. They lack a sense of urgency regarding S&T achievements, so there has been no way for a technology buyers' market to form. If this continues, enterprises will lack vitality and reserve strength, and it will affect the initiative of scientific research departments for technical development.

4. Expenditures on technology imports, assimilation, and purchasing Chinese-made technologies. According to 1985 statistics, enterprise expenditures used to purchase Chinese-made technologies amounted to only 1/50th of expenditures on technology imports. Expenditures for assimilation accounted for only 1/9.43 of expenditures on technology imports. Expenditures to purchase Chinese-made technical achievements accounted for only 0.38 percent of total expenditures on technology. Importing advanced foreign technologies and equipment has played a very good role in improving China's production technology standards, but the above-mentioned loss of coordination also indicates that inadequate attention has been given to assimilating the imported technologies and to utilization of Chinese-made technical achievements. Many large and medium-sized enterprises would prefer to spend large amounts of foreign exchange to purchase foreign production lines and technical equipment, but they are unwilling to spend much less money to purchase Chinese-made technical achievements at similar levels. Moreover, repetitious importing is common, and cost of importing may be more than 50 times greater than the cost of purchasing Chinese technology. This definitely shows that we lack macro-level management and policy coordination. In addition, no concern is given to assimilation after the technologies are imported, which has made the cost of importing 9.43 times that of assimilation. In post-war Japan, scientific research expenditures for assimilation were 9.36 times expenditures on imports, so the two figures are exactly the opposite, which indicates that China's enterprises are concerned only with immediate gains

and are dependent on foreign technologies. The proportion of total enterprise expenditures on technology which are used to purchase Chinese-made technical achievements also is frighteningly small. This indicates that many large and medium-sized enterprises are ignoring the adoption of Chinese-made S&T achievements and that they are ignoring the utilization of the strengths of scientific research units to assist in their own assimilation, which was caused serious detachment of Chinese-made S&T developments from enterprise technical progress.

5. Expenditures on technical transformation. According to 1985 statistics, expenditures on technical transformation in China's large and medium-sized enterprises amounted to only about 1/20th of the net value of fixed assets. This indicates that China must spend at least 20 years before we can complete renewal and transformation of existing fixed assets. In the United States, Japan, and other nations, however, only 5 to 8 years' time is required. It is apparent that our current inputs of expenditures on technical transformation are too small. This is a primary factor which restricts technical progress in China's enterprises.

6. Enterprise profit retention levels. Current profit retention levels in China's large and medium-sized enterprises amount to only about 17 percent of total profits. Based on the relevant state decisions, although enterprise expenditures on technical development can be included in costs, the fact that profit retention levels in enterprises are too low means that enterprises are unwilling to reduce their retained profits in exchange for an increase in input of expenditures for technical development.

II. Policy Suggestions

As mentioned previously, technical input in China's industrial enteprises is too small, there is a serious lack of expenditures on technical development and new product development, and there is a loss of coordination between technology imports and assimilation and in the adoption of Chinese technology. Expenditures for technical transformation are too low, as are enterprise profit retention levels. These factors restrict technical progress and economic growth in enterprises. This involves problems in the enterprises themselves as well as problems in the area of management and policies. To change this situation and create a favorable environment for enterprise development as quickly as possible, we offer the following suggestions in the hope that they will attract the attention of relevant areas.

1. Readjust state investment policies and strive to increase S&T input in enterprises. We hope that within 3 to 5 years, expenditures on technical development in large and medium-sized enterprises will increase from the present 0.3 to 0.86 percent of the total volume of product sales to 1 to 2 percent. Expenditures for new product development should rise from the present figure and only 0.12 to 0.32 percent of the total volume of product sales to more than 1 percent. On the one hand, this would require readjustment and increase of state S&T input in enterprises. On the other hand, we should encourage the enterprises themselves to come up with ways to increase their internal S&T inputs.

2. Study and formulate economic policies to promote technical progress in enterprises. Examples include policies to encourage new product development; policies to heavily tax old products made with backward technologies; and formulating standards for examining technical progress in enterprises, and reinforcing examination work.

3. Use intensive implementation of economic system reforms and contractual responsibility systems for enterprise management to improve economic results in enterprises, increase profit retention levels in enterprises, and give enterprises greater vitality, which in turn will improve their conditions for carrying out technical development.

4. All levels of government should strengthen reforms in S&T appropriation patterns and foster the initiative of financial systems to invest in enterprise S&T progress. In the future, we should strengthen financial appropriations to enterprises by banks, reduce state administrative appropriations, and rationally guide capital circulation. First of all, we should support enterprises in active pursuit of technical progress and improve the results of S&T investments.

5. Propose that all of society support S&T progress in enterprises. All institutions of higher education and research units should take action to shift their own scientific research achievements into enteprises and convert them into forces of production as quickly as possible. All large and medium-sized enterprises should establish special S&T development departments, and all types of small enterprises should use integration to establish S&T development service centers to expand the application of science and technology, broaden the scope of their radiation, and increase the technical development capabilities of the enterprises themselves.

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R&D Attainments in the Field of New Materials Reviewed

40080096c Beijing ZHONGGUO KEJI LUNTAN [FORUM ON SCIENCE AND TECHNOLOGY IN CHINA] in Chinese No 1, 1988 pp 35-36

[Article by Pei Li [5952 7812]: "China Makes Many Great Achievements in Developing New Materials"]

[Text] New materials are the foundation for the development of new technologies as well as a component of new technologies. Progress in materials and the development and utilization of the new materials can have major effects on technical progress, economic growth, and social development, and they are of great significance for national economic construction and national defense modernization in China. The materials industry also has the important esponsibilities of transforming traditional industries and technologies and developing new industries.

Over the part 20-plus years, China's materials industry has come into existence and grown. It now has become a new industry with a substantial scale of research and experimentation and with several production base areas. It has developed more than 10,000 kinds of new materials and trained crack S&T staffs. We now can produce semiconductor materials, special metals and alloys, new types of chemical industry materials, new inorganic materials, new fuels, synthetic lubricants and resins, and many other new materials. China's materials industry has made new breakthroughs and developments in the situation of reform and opening up, and it has developed many new materials which have effectively promoted the emergence and development of many new industrial technologies in China including electronics products, integrated circuits, electronic computers, new energy resources, and so on.

During attacks on key S&T topics in the Sixth 5-Year Plan, great achivements were made in new materials R&D in China.

In the area of materials associated with key national defense projects, new materials for products of more than 3,200 specifications were provided for China's geosynchronous satellites, various types of strategic and tactical weapons, new types of fighter planes, naval vessels, atomic energy, and other things which guaranteed the smooth completion of key project construction on schedule.

In the area of developing organic polymer materials, key S&T topics were attacked and technical developments were completed at the 10,000-ton level for organic silicon, 10,000-ton level for the thermoplastic engineering plastic PBT. The technical conditions and engineering technology and equipment conditions required to build large industrial enterprises were provided. More than 80 organic silicon products with wide applications in the textile, light industry, electronics, energy, communications, construction materials, and other industrial sectors have been developed. They have created directly an additional 5 million yuan in value of output and 3.2 million yuan in taxes and profits for the state each year. Their indirect benefits are even greater. For example, using organic silicon in the textile area can raise product quality grades. Shanghai Municipality alone can export enough products each year to increase its income by more than 100 million yuan. It has studied fluorine plastic processing technologies and focused on development of large pipes, equipment linings, spray technologies, guide furring flexible belts, sealed components, and so on, and the results from their extension and application are apparent. Silicon rubber has attained wide utilization in the steelmaking industry. At the Capital Iron and Steel Complex, for example, an improved design which uses a silicon rubber sealing ring instead of traditional sealing methods at the top of blast furnaces increases furnace pressures, and it has extended the useful life by 4.8 times and guaranteed stable high output. China also has made gratifying achievements in research on sesbania rubber technologies and applications, and the product has almost attained the level of elite world rubber (guar rubber). Sesbania rubber has broad applications in the papermaking, ceramics, battery, textile, plastic explosives, food products, and other industries and its applications in the petroleum industry can provide economic benefits in excess of several 100 million yuan, so its developmental prospects are excellent.

In the area of electronics and information materials, the joint efforts of materials science research departments and electronic applications departments during the Sixth 5-Year Plan also produced continual developments. Preliminary statistics indicate that more than 1,500 of the 3,000 new materials development tasks required by the electronics industry were completed, which has raised China's self-sufficiency to around 50 percent. The primary materials used to manufacture color TV picture tubes are an example. In the past, we relied mainly on imports, but about one-half now comes from domestic sources. Other examples include high-resistance silicon, germanium monocrystals, chemical compound semiconductor materials, and high-purity metals used in detectors, powdered tantalum used in capacitors, shadow mask steel bands used in picture tubes, non-magnetic stainless steel tubes, and microchannel plates used in second generation low-light night vision scopes. Attacks on key technical problems over the past several years have pushed product technical performance indices almost up to or up to foreign 1980's levels. They have satisfied demand in China, and some products now are being exported. China has made significant achievements in the development of artificial crystals. BGO and KTP crystals, important products needed for the development of advanced technologies, are an example. They now have attained advanced international levels. In addition, research on a non-evapotranspirative air removing agent used in electrovacuum components has pushed the performance indices of the Chinese-made product past Italy's SAES Company, and it now is widely used in military

and civilian equipment. This product now is used in one-third of China's fluorescent lamps, and it conserves energy and has extended the useful life of the light tubes. China has produced many chemical industry electronics materials and ceramic electronics materials over the past few years which have improved the quality and stabilized the performance of many traditional electronic components and products, and accelerated the development of the electronics industry.

In the area of basic materials used in large-scale integrated circuits (LSI), the demands for 1K, 4K, and 16K memory circuit development and production basically have been satisfied both in quality and quantity in recent years. Silicon materials are the key materials for large-scale integrated circuits. During the Sixth 5-Year Plan, we built several production lines capable of making 2-, 3-, and 4-inch diameter P-type and N-type monocrystalline silicon with different resistance values as well as the associated slicing, grinding, and polishing technologies, and so on. Moreover, there was successful trial manufacture of 22 types of ultra-pure "0"-grade chemicals and six types of "00"-grade high purity reagent samples. In the area of developing ultra-pure gases, high purity quarts, high purity graphite, ultraviolet light rubber engraving, lead frame materials, plastic sealing materials, silicon chip polishing materials, and ultra-pure water purification materials, tasks were completed according to plans and they basically met the needs of semi-conductor integrated circuit research and production in China.

In the area of steel and compound materials for atomic energy, as well as energy and energy conservation materials, attacks on key problems during the Sixth 5-Year Plan developed more than 230 new products and built a group of research, trial manufacture, and production base areas on a preliminary scale. The hydrogen-resistant pressure vessels used in the atomic energy industry place special demands on steel materials. The products we now are developing have performance indices which have attained the level of similar foreign products, and they have gone into large-lot production. The G817 steel we developed was a central steel at the Gezhouba Power Station. Its resistance to atmospheric corrosion gives it a useful life more than 2 times longer than the former imported steel, making it possible to extend the major overhaul schedule by a factor of more than one. The results were excellent after it was put into use. The high aluminum oxide fibers we developed now are being used in 49 of the Taiyuan Steel Mill's 300 kW high-temperature heating furnaces. It has resulted in energy savings of about 25 percent since being placed into operation, so the results are obvious. In addition, the performance in use of the high-temperature structural ceramic cutters and the horizontal continuous casting separating ring products we have developed has attained advanced international levels. We have completed an intermediate testing and production base area which can produce lithium strips up to 200mm wide for high-efficiency battery materials. The glass fiber reinforced plastic railroad window frames we developed are lighweight, corrosion resistant, attractive, and easy to use, and they are being used in more than 900 railway cars. Our achievements in research on rare earth compounds for agricultural purposes have been used in crop production and now are being demonstrated and extended over an area of 12 million mu. They are being used for rubber tapping production over an area of 100,000 mu, with an input/output ratio of 1:7. Their economic results are good and they have entered the front ranks internationally.

China's achievements in attacks on new materials and their extension and utilization indicates that research in China in this field has grown and entered a new stage, and it has benefits not only for technical transformation in traditional industries but also has laid a solid foundation for the development of advanced technologies. While acknowledging our achievements, we also should understand clearly that China lags considerably behind the developed nations in new materials varieties, systems, quality, costs, R&D technical standards, experimental conditions, analytical inspection and measurement methods, and other areas. We also must take note of the challenge we face in the world's new technological revolution, so our tasks continue to be rather difficult ones.

During the Seventh 5-Year Plan, projects for attacks on key questions with new materials in China mainly include: electronic and information materials, organic separation membranes and membrane technologies, high-temperature structural ceramics, compound materials, non-crystalline materials, and so on. They include topics for technical transformation of traditional industries, and they include topics arranged to provide the required material foundation for the development of advanced technologies and the formation of new industries. They also include some preliminary research topics to bring us up to advanced international levels and lay a foundation for future development. All of these projects have been fully implemented, and the scroll for attacks on key topics with new materials during the Seventh 5-Year Plan has been unfurled. We firmly believe that, guided by the principles of reform, opening up, and invigorating and through several years of effort, many new materials which are urgently needed for the four modernizations drive will appear. These new materials will provide the material foundation for China's national defense construction and for updating and replacing China's strategic and tactical weapons. They will create a new situation in the development of China's national economy.

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Analysis of Impediments to Spark Plan and Relevant Policy Measures

40080096d Beijing ZHONGGUO KEJI LUNTAN [FORUM ON SCIENCE AND TECHNOLOGY IN CHINA] in Chinese No 1, 1988 pp 49-51, 54

[Article by Wang Yicheng [3769 3015 2052]: "Analysis of Impediments to 'Spark Plan' Achievement and Thoughts on Countermeasures"]

[Text] Trial implementation of the "spark plan" began in 1985. It has been universally welcomed throughout China since full implementation in 1986, and preliminary results are being seen. Statistics for the last half of 1986 indicate that 70 percent of the 4,018 "spak plan" projects at all levels in China have attained stage results, which indicates the excellent economic prospects for the "spark plan." Hubei Province had 293 "spark" projects at all levels in 1986, and 71 percent of them had been completed and produced results by the end of the year. They created 180 million yuan in value of output, and earned more than 40 million yuan in net profits. When the projects are finished, they can create 1.038 billion yuan in value and 314 million yuan in taxes and profits with an input/output ratio of up to about 1:7. Hunan Province had 127 "spark" projects at the prefecture (city) level and above, and they may produce more than 970 million yuan in additional economic benefits and over 200 million yuan in taxes and profits after they go into operation. Hebei Province completed 98 percent of plan progress by the end of 1986 with an average input/output ratio of 1:4, and each 100 yuan in investments can produce more than 100 yuan in profits. The facts have confirmed that the "spark plan" has played and is playing an important role in reinforcing horizontal integration between S&T and the economy and in relying on S&T to invigorate the rural economy, and that a full estimate should be made of its enormous significance for agricultural modernization in China.

Nevertheless, "spark plan" implementation has just begun, and since it is an enormous social engineering project, it is inevitable that it will be less than perfect in many locations. Because it is developing now, it is possible that it will encounter many problems and impediments. To ensure that it develops in a healthier fashion, it is quite necessary that problems which appear during the implementation process be studied, that estimates be made of problems which may appear, and that the corresponding countermeasures be proposed on this basis. Impediments which may appear during "spark plan" implementation can be divided into several main areas:

1. Conceptual impediments. Focus on the operational mechanisms, developmental laws, coordinating relationships, social functions, and other aspects of the "spark plan" and suggest many theoretical questions and practical problems which must be solved. Examples include: How can the "spark plan" be coordinated with development of the rural commodity economy and system reforms? How can the "spark plan" be coordinated with technology markets? How can we get rid of former traditional management patterns in rural areas? And so on. The weakness of the concept of reform, the concept of commodities, the concept of markets, the concept of competition, the concept of coordination, the concepts of efficiency and results, and so on, as well as the resistance of the traditional closed concept of small-scale agriculture, have caused imbalances in understanding during "spark plan" implementation. For example, a few regions and units still do not treat the "spark plan" as the order of the day, so their coordination with relevant departments has been poor and implementation has been ineffective.

2. Capital impediments. Capital is an important prerequisite for effective "stark plan" implementation. It refers mainly to the two main areas of capital raising and rational utilization. The problems at present are: First, a failure to allocate administrative expenditures has made implementation of several "spark plan" projects impossible. Second, an excessive number of projects has scattered capital and the results of investments have not been very good. There are "too many monks and not enough gruel" and utterly inadequate resources, so it is hard even to meet the basic requirements for project implementation. Third, administrative expenditures are allocated too late. Many projects submitted their loan requests during the first quarter but they still had not been processed by the end of the year, and the loans were delayed so long that they could not be allocated. The problems reflected in capital impediments include policy factors as well as management factors.

3. Personnel impediments. The key in using S&T to invigorate the local economy and township and town enterprises is to develop "short, smooth, and fast" technologies. Among these, the most crucial factor is engineering and technical personnel, so the personnel question naturally should receive special attention during "spark plan" implementation. However, because of various conceptual, system, policy, and management factors, personnel questions in "spark plan" implementation continue to be extremely prominent, and 30 percent of the projects in some provinces have inadequate technical forces. The critical problems are: First, they are unable to create a strong attractive force for S&T personnel. Second, they are making only weak efforts. Many S&T personnel who work in township and town enterprises or who have moved into rural areas are moving continually into politics or flowing into the cities, and the tendency toward personnel reductions in township and town enterprises continues unabated. Third, inadequate attention is given to existing S&T personnel, and closed management patterns and egalitarian treatment have precluded motivating their initiative fully. Fourth, the inevitable result of the quantitative lack of S&T personnel and ideological instability is that interrelated problems are created during "spark plan" implementation; technical backing is not provided, technical debate is incomplete, technical cooperation is hard to organize, and technical development schedules are too long. These problems have severely affected economic, social, and ecological results.

4. Management impediments. "Spark plan" management includes both macro and micro levels. Macro management involves unified arrangements, rational project deployments, and control to realize overall goals. Micro management uses concrete debate and project implementation to guarantee limited project goals. The actual situation is that "spark plan" management levels come far from meeting the objective demand for effective implementation. In macro management, "spark plan" project deployments are not sufficiently rational and there is an inadequate fit with the medium and long-term goals of economic and social development strategies. Some projects are not sufficiently oriented toward rural areas and township and town enterprises, and the content of technical development is not prominent enough. These are manifested as weak overall macro guidance. In micro management, there is a shortage of management personnel in the responsible units and overall management levels are universally low. It deserves particular mention that because of management system shortcomings, too many levels are involved in project examination and approval and loan requests, procedures are too complex, schedules are too long, and efficiency is low. This not only affects effective "spark plan" implementation but also has severely damaged the initiative of some cadres. In addition, in the area of project debate, the lack of systematic market readjustments and scientific forecasts have prohibited strict adherence to the necessary scientific debate procedures, which has lead to inadequate discussion, incorrect point selection, and even occasional blind selection of fixed points, which has affected results.

5. Benefit impediments. "Spark plan" benefits should include comprehensive economic, social, and ecological benefits. Some units and regions have not pursued comprehensive benefits adequately during "spark plan" implementation. They have been concerned only with immediate and partial economic benefits without sacrificing for long-term comprehensive economic benefits, to the extent that they are unconcerned with the severe social and environmental results caused by ecological destruction. During "spark plan" implementation in some areas, there also have been classical examples of failures even to consider economic benefits. Administrative measures are employed to extend certain technologies blindly without concern for conditions, the result being huge economic losses. Benefits, however, are the life-source of the "spark plan." They are an objective yardstick for evaluating the effectiveness of "spark plan" implementation, and they are an important motivating force for sustained and effective application.

6. Policy impediments. Although central authorities as well as provinces, municipalities, and autonomous regions have formulated certain policy decisions for "spark plan" implementation, policy research to coordinate S&T with the economy and society continues to stagnate. Concrete supporting policies are not matched up and some policies are not being implemented stably or are meeting resistance. Overall, policy impediments are manifested primarily as a lack of comprehensiveness and neglect of overall effects. For this reason, based on "spark plan" implementation mechanisms and overall state principles and policies, we should integrate with reality in each area to formulate the corresponding policies, laws, regulations, and articles and assure that they are coordinated and matched up to form comprehensive effects. This has become one of the key factors for guiding, promoting, and guaranteeing effective "spark plan" implementation.

To overcome these impediments and improve "spark plan" implementation mechanisms so that they achieve high efficiency and high benefits and become widespread, we can envisage the adoption of corresponding policies in these areas.

1. Reinforce research in the "soft sciences" for the "spark plan", strive to strengthen "spark" consciousness.

First, we should organize some "soft science" research forces to study the various theoretical and practical questions suggested during "spark plan" implementation in a timely fashion. This would include retrospective research, tracking research, prospect forecasts, and so on. Research in the "soft sciences" is essential to enable everyone not only to grap perceptually but moreover to be able to gain a deep rational understanding of the operational laws and interrelated questions of the "spark plan" itself. Second, we should carry out the necessary popular propaganda about "soft science" research achievements in the spark plan" to give personnel concerned with the "spark plan" a stronger understanding. A stronger understanding of "sparks" will provide an important ideological guarantee for effective "spark plan" implementation.

2. Implement rational capital matching, improve capital utilization and management.

Current capital matching patterns employ a method in which the state, local areas, and units responsible for projects each assume one-third of the burden. In capital matching, with the exception of part of capital matching from local revenues which has not been implemented, capital matching has not been implemented in many units responsible for projects, and some are even converting existing equipment to capital to supplement or reduce matching portions, and they place their hopes on support form state revenues, so of course efficiency cannot be very high. To implement capital matching, it is extremely necessary that the corresponding reward and punishment methods be formulated. Units responsible for projects which complete plans on or ahead of schedule and which derive excellent results should receive preference in financial support for subsequent projects. Otherwise, they should be punished economically to varying degrees. State financial administrations and banks should give financial rewards like preferential discounts to areas which complete "spark plan" projects and attain excellent economic results, or they should be permitted to retain a portion when the loans are repaid.

3. Formulate systematic "spark plan" personnel policies, strengthen personnel attraction and condensation.

S&T personnel are the carriers of science and technology into rural areas. A key to effective "spark plan" implementation is to strengthen the attraction and condensation of S&T personnel, and this requires the corresponding personnel policies. However, policies to attract S&T personnel cannot be understood only as material treatment and material reward policies. Why are some areas unable to attract and keep S&T personnel even though they have formulate liberal material treatment policies? The key is that many problems which S&T personnel are most concerned with and sensitive to have not been dealt with. Examples include the question of academic acknowledgement of S&T labor in "spark plan"

implementation; the question of information replenishment for S&T personnel after they go into rural areas to work in medium and small enterprises and in township and town enterprises; the question of the demands of S&T personnel for administrative policy stability, and so on. The essence of academic acknowledgement policies is using the results of "spark plan" implementation as the primary indices to evaluate, recruit, and promote technical employees. The essence of information replenishment policies is that they should use concrete decisions on continuing education, going abroad for inspections, refresher courses and advanced studies, scholarly exchanges and so on for personnel involved in "spark plan" implementation to remove their fear of being unable to receive information replenishment after they leave the central cities. The essence of stable administration policies is to use real stabilization and supervision of effective existing policies to remove everyone's fears about policy changes so that they feel safe in taking up "spark plan" project development and administration.

4. Improve "spark plan" system management, increase "spark plan" implementation efficiency.

The various impediments and problems encountered during "spark plan" implementation at present are directly and indirectly related to management problems to some degree. The State Science and Technology Commission and all provinces and municipalities have formulated "spark plan" implementation programs. The most urgent task now is timely supplementation so that scientific management permeates all aspects and the entire process of "spark plan" implementation to basically eliminate single-item management-by-urgency patterns and establish true systematic management.

5. For optimum project systems, pursue high comprehensive system benefits.

The demonstration function revealed in sustained high economic results continues to be the key to successful "spark plan" implementation. Still, every project with high economic results cannot become a "spark" project because the high economic results of "spark" projects are attained via advanced science and technology, not through the usual expanded reproduction. It is apparent that increasing wealth through S&T is the soul of "spark" projects. If we wish to create wealth via S&T, then technology, information, and management must be integrated well, and technical development, product production, and market administration must be integrated well. Among them, particular attention should be given to the advantages of each area as well as to rational organization and coordination so that single advantages become an advantage system, after which comprehensive sytem advantages can then be motivated. We also should focus on key advantages in this system, accelerate the materialization process of advanced techniques, and integrate new product development, intensive product processing, and smooth commodity circulation to achieve increased value in the product. High comprehensive system benefits are reflections of the systematic requirements of the benefits themselves, and they include two aspects. One aspect is achieving "hard technology" benefits through the materialization of advanced technologies, striving for more "soft technology" benefits from the introduction of advanced management techniques, and making the two complement

each other. The second aspect is to form economic, social, and ecological benefits into high comprehensive benefits. Usually, economic benefits are restricted by social and ecological benefits. If there are poor social and ecological benefits, such economic benefits would be hard to derive or would be only temporary. This means that unified consideration must be given to long-term and short-term, and to total and partial benefits.

6. Reinforce policy systemization, foster beneficial comprehensive policy benefits.

"Spark plan" policies are multifaceted, and include capital matching, credit, taxation, prices, materials, personnel, awards, and other policies. There are two requirements for the achievement of policy sytemization. One is internal system matchup for each single policy. Examples include personnel policies, which should give full consideration to wages, welfare, training, promotion, circulation, and other aspects, since otherwise they will lack an attractive and condensing force. The second is system matchup among various policies. For example, in the circulation of personnel toward medium and small enterprises and township and town enterprises, with the exception of the need to perfect policies concerning personnel themselves, there also must be coordination of the other associated policies. Obviously, the most important among them are certain policies related to system reforms. The reason is that if we fail to implement policies to separate ownership rights from management rights, and do not formulate and implement policies for hiring, responsibility, technical shares, and so on for medium and small enterprises and township and town enterprises, then personnel circulation will be difficult.

Of course, policy systemization must be established on the basis of continual improvement of each policy since otherwise it will be impossible to form systems. Without excellent organizational components, talk of establishing optimized systems is meaningless.

The main goal in policy systemization is to give fuller play to the beneficial comprehensive effects of policies. These beneficial comprehensive benefits are manifested in: first, aiding in overcoming ill-adapted aspects of original policies; second, favoring support for rational changes in single components of policy systems and overcoming continued maintenance of conservative tendencies during policy implementation; third, favoring increased overall coordination of the colony of overall S&T, economic, and social policies in "spark plan" system policies. The beneficial comprehensive effects of policies should motivate us to integrate "spark plan" implementation with all aspects of system reforms and overall social progress to turn it into a process of developing forces of production as well as a process of changes in production relationships and thereby promote enormous development of the overall rural commodity economy and accelerate the pace of agricultural industrialization. "Spark plan" projects transplant the "genes" of S&T into rural areas and will lead to the final realization of the magnificent goal of fundamental changes in traditional backward production patterns and living patterns.

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Deregulation, Contract System Said Key to Further S&T System Reform

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[Text] It has been 3 full years since the CPC Central Committee came up with the "Decision on Scientific and Technological Structural Reform." Three years of reform practice proves that the decision to reform the scientific and technological system is totally correct. It has liberated scientific and technological productive forces, mobilized the initiative of vast numbers of scientific and technical personnel, and brought science and technology, on the one hand, and the economy, on the other, even closer together. People began learning anew and revaluating the pivotal role played by science and technology in powering economic and social development. For the first time in the history of the Chinese people, the 13th National Party Congress put scientific and technological development at the forefront of the national economic development strategy.

Reform is the only way to vitalize China. It is a historical trend that cannot be reversed and accords with the will of the people and the general flow of events. Guided by the spirit of the party's 13th party congress, economic, political, scientific, technical, educational, and other reforms are entering a new stage in China. The most fundamental goal of reform is to develop social productive forces. All reform must be carried out to accomplish the central task of developing social productive forces. Reform is a gradual and steadily intensifying process. Old contradictions are resolved only to be replaced by new ones. Scientific and technological structural reform involves many aspects--economics, politics, and eduation--and must be coordinated and proceed in tandem with other reforms. Only that way can reform as a whole be the dominant harmonious theme in promoting the development of social productive forces. In light of the present situation, scientific and technological reform in 1988 should focus on the consolidation of existing reform achievements, the furthering of the "two deregulation" and the extensive application of the contracting system in all its diverse forms. We should speed up reform and bring about closer integration between science, technology, and the economy.

The primary stage of socialism faces the mission of developing a full commodity economy. And the commodity economy can achieve economies of scale and basically raise social productive forces only with the support of modern science and technology. At present, the key to accelerating the marriage between science and technology and the economy is further introducing competitive and market mechanisms and pushing for the commercialization of

technical achievements vigorously. To firmly inculcate the idea of serving the commodity economy among scientific research institutions and make scientific and technological work follow market demand, we must actively implement the contracted management responsibility system in all its forms and shapes and separate the ownership and management of scientific research institutions. We must encourage research institutions to orient themselves to society by practicing open bidding and selecting operators through competition between various kinds of enterprises, institutions, collectives, and individuals. We must formulate policies to allow scientific research institutions that go in for contracted management to determine the direction of scientific research, scope of operations, and staffing on their own and carry out an internal wage system and a scientific personnel appointment system. Within a scientific research institution itself, there may be contracting level by level. To invigorate enterprises and stimulate their technical needs and developmental ability, we should combine the reform of their operational mechanisms with technical progress. Our policies should state explicitly that criteria of technological progress are part of the overall system of criteria for evaluating the enterprise contracted management responsibility system, the director (manager) tenure and goal responsibility system, and the grading of enterprises. That way, technical progress criteria will be directly related to the interests of operators and producers. We must further clear up the circulation channels for technical achievements, successfully convert such achievements into industrial products, and make science and technology permeate every part of the commodity economy and therefore become its genuine pillar.

Science and technology not only must orient itself to the economy, but must also penetrate into and embed itself in the economy. A crucial task of the acceleration and intensification of scientific and technological reform is to make science and technology and the economy one and the same thing. We should see that as reform deepens and scientific and technological progress plays an increasingly important role in production, research institutions and productive enterprises have been undergoing structural and organic changes. Some scientific research institutions have been absorbed into an enterprise or group of enterprises. Some are forming a technical development center for the industry they belong to. Some are embarking on the commercialization of scientific research. And some are using their technical superiority to attract a host of small and medium-sized enterprises. Nevertheless, the isolation of scientific and technological work from economic activities remains fundamentally unchanged. Much scientific and technological forces have still not been channelled into the development of new products, technical transformation, and the assimilation of imported technology. Thus, further deregulating scientific research institutions, broadening the road toward scientific-economic integration, speeding up scientific and technological reform in a coordinated way with economic reforms--all this remains basic to scientific and technological structural reform this year and for some time to come. We should allow the exploration and innovation of all practices favorable to the full utilization of scientific and technical personnel and the development of productive forces. We should encourage and support scientific research institutions to permeate and penetrate into the economy in every form, thus turning themselves into a new kind of scientific research business entity. Apart from the various forms of association and integration

already in existence, the scientific research institution may contract, lease, or purchase an enterprise. Drawing sustenance from an urban center, a coastal opened zone, or an area with a heavy concentration of expertise, a scientific research institution may create or establish in partnership with others a branch institution, a company, an enterprise, or a corporation of any one of a variety of forms of ownership. That would gradually bring about the integration of scientific research and production and the socialization of the management of scientific research institutions.

The deregulation of scientific and technological personnel lies at the core of reform and the open policy in the primary stage of socialism and is a pivotal measure for intensifying structural reform. We must steadfastly propel our scientific and technological forces to the main battlefield of national economic construction. Thus far 360,000 scientific and technological personnel across the nation have gone to small and medium-sized enterprises, township and town enterprises, and the countryside to engage in contracting and offer technical services. They constitute the backbone of a contingent that will lead the masses in developing a socialist commodity economy supported by science and technology. However, there are still not enough people in the current scientific contingent who have fresh entrepreneurial thinking. There is still not enough entrepreneurial drive. This year we must continue to take all kinds of actions to propel large numbers of scientific and technical personnel to the forefront of economic construction. In particular, we must attract them to enter contracting and leasing and head up small and medium-sized enterprises and township enterprises in order to make the transition from a fragmented natural and semi-natural economy to scale economies. Accordingly, we must make the rank-and-file scientific worker realize that the primary mission of scientific and technological work is to vitalize the national economy and that the most important element in modern productive forces is scientific and technological personnel, hence reinforcing his sense of historical responsibility. On the other hand, we must take practical measures to relieve him of his concern over technical position, housing, welfare, and insurance. We must encourage him to improve his own material condition by creating wealth for society. We must allow enterprises and institutions with good financial returns to improve wages for their scientific and technical personnel using earnings outside the plan. We must encourage enterprises and institutions that practice contracting to raise wages for scientific and technological personnel without exceeding the total payroll. We must begin pilot projects in the socialized management of wages, housing, permanent residential registration, record keeping, and social security of scientific and technological personnel. Only thus can we weaken the unit proprietorship of qualified personnel and their attachment to the "iron rice bowl" and reinforce their enthusiasm to plunge into the main battle of economic construction.

Another major issue facing the scientific and technological community is to speed up and intensify scientific and technological reform in agriculture, adapt the scientific and technological system to large-scale operation in agriculture, and make science and technology available to tens of thousands of households in the vast countryside. This year departments in charge of agricultural science and technology at all levels should reform the dissemination system of agricultural technology by gradually putting together a technical

dissemination service network relying on operational entities of diversified ownership at different levels and well suited to the development of the rural commodity economy. They should conduct experiments, demonstrations, training, and dissemination in agricultural technology more effectively. Scientific research institutions, institutions of higher education, and enterprises should all actively orient themselves to the village and be its powerful scientific and technological pillar. Economic entities of all forms must be created or jointly established to develop a rural commodity economy buttressed by science and technology.

It was proposed at the 13th NPC that the State Council draw up a medium- and long-term scientific and technological development plan. This task so vital to scientific development and overall modernization, is now under way feverishly. It is also a major event for the scientific and technological community. The formulation of the plan embodies the party's highest regard for scientific and technological development and its high expectations from it. The medium- and long-term scientific and technological development plan will clarify the objectives and scientific and technological development and lay down major measures and related policies. Once approved, it will no doubt be a powerful impetus to expediting scientific and technological structural reform and exert an inestimable influence on the full utilization of science and technology in economic growth and social advances. Let us welcome the birth of the scientific and technological development plan with joy and inspiration and prepare ourselves to offer all our wisdom and abilities unselfishly to its implementation.

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Statistical Profile of Science and Technology in China

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[Text] 1. Accumulation of Scientific and Technological Resources Year After Year.

Scientific and technological resources are a key element with a long-term impact on the national economy. Developed nations invariably take scientific and technological inputs and their ratios with other social economic variables seriously and often use them to measure their relative international competitiveness.

The presence of a scientific and technological contingent of a fairly high quality and a decent size, absolutely and relative to its population, is closely related to a nation's economic development. Up to 1985, institutions of higher education and secondary technical schools in China had turned out a total of 4,898,500 and 8,574,800 graduates, respectively. These included the 1,767,200 and 2,821,700 students that graduated from institutions of higher education and secondary technical schools, respectively, in the 7 years between 1979 and 1985, outnumbering their predecessors who graduated in the 17 years between the founding of the PRC and the eve of the Cultural Revolution or the 13 years between the beginning of the Cultural Revolution and the 3d Plenum of the 11th CPC Central Committee. Nevertheless, China still lags other developed nations in the number of university graduates per 10,000 population and is roughly where the Federal Republic Germany [FRG] was in the early and mid-1950's and worse off than India. As far as the growth rate is concerned, China has been moving rapidly. Between 1979 and 1985, its annual growth rate averaged 7.7 percent, one- or two-fold higher than developed nations. By 1986, China's scientific and technological personnel already numbered 8,253,100, having increased by 3,908,000 in the 8 years between 1979 and 1986, for an average annual increase rate of 8.35 percent. In units owned by the whole people, there were 884 scientific and technological workers for every 10,000 workers, up from 593.3 in 1978, for an average annual increase rate of 5.11 percent.

Research and development [R&D] is a systematic and organized form of social practice whereby mankind increases knowledge and applies such

knowledge to invent new uses and open up new areas of application. At present, scientific and technological personnel in R&D institutions under all state organs, in institutions of higher education, and in large and medium-sized enterprises stand at 1,058,000 (including 605,000 scientists and engineers calculated in accordance with international statistical rules), 12.35 percent of all scientific and technological personnel in China. Of the 1,058,000 people, 543,000 worked in R&D institutions under state organs above the county level. This group increased 9.6 percent annually on the average between 1978 and 1986. The increase rate was particularly high among scientific and technological personnel in R&D institutions under various State Council ministries and under the provinces, autonomous regions, and municipalities directly administered by the central government, who expanded by an average annual rate of 10.71 and 9.75 percent, respectively. Large and medium-sized enterprises had 372,000 scientific and technological personnel, 1.58 percent of their total workers.

Scientific research funds and miscellaneous resources (equipment, apparatus, buildings, and factories) are an important material guarantee of R&D. In the past 2 or 3 decades, all developed nations attached much importance to material inputs in science and technology. Since the 3d Plenum of the 11th CPC Central Committee, China too has made a good deal of effort in this regard. Of government expenditures between 1979 and 1985, spending on culture, education, science and technology, and public health all increased by an average 15.7 percent each year. Enterprises spent 5.2 percent more each year to tap potential and transform themselves. New product development funds went up 7.7 percent each year on the average, roughly the same as margins of increase in government spending, the gross value of industrial and agricultural output, and national income (6.4 percent, 13.1 percent, and 12.6 percent, respectively). Scientific research spending by R&D institutions under state organs above the county level, institutions of higher education, and large and medium-sized enterprises amounted to 15.37 billion yuan, 1.15 percent of the gross value of industrial and agricultural output (approximately equal to the level in the FRG and Japan in the 1950's and 1960's, converted in accordance with international comparability rules.)

As for the sources of R&D funding, government investment accounted for 43.3 percent. If we look at the different kinds of spending, personnel expenses made up 15.6 percent, operating expenses, 23.8 percent, and asset acquisition and capital construction expenses, 35.1 percent. In terms of fund distribution among the different types of research institutions, R&D institutions under state organs above the county level accounted for 59.3 percent; enterprises, 37.4 percent (about 1 to 2 percent of product sales); and institutions of higher education, 3.3 percent. These figures were roughly equivalent to those in some developed nations after the war.

2. Scientific and Technological Operating Mechanisms Are Being Transformed

A series of reforms took place in scientific and technological

management after 1979. To begin with, work order and organizational structure were improved through restructuring and restoration. Then the CPC Central Committee unveiled the strategic principle that "economic work must rely on science and technology, and scientific and technological work must be geared toward economic construction," clearly pointing up a direction for economic and scientific and technological work. Later, all R&D institutions began technical contracting internally and lining up technical contracts externally. Particularly after March 1985, when the CPC Central Committee issued its decision concerning scientific and technological structural reform, reform took one big step forward in the operating mechanisms of the entire system.

1) The technical contracting system is gaining ground. Statistically, already 1,910 R&D institutions under state organs above the county level have adopted the technical contracting system, including 533 which are economically self-supporting, 36.2 percent and 10.1 percent, respectively, of the total. In 1986, the number of workers in economically self-supporting units made up 9.54 percent of the total number of workers of R&D institutions under state organs above the county level, up from 4.01 percent in 1984, while the proportion of scientists and engineers was 6.36 percent, up from 2 percent in 1984. Of these institutions, 42, or 4.56 percent, were under the State Council, up from 7, or 0.88 percent, and 491, or 11.62 percent, were under various provinces, autonomous regions, and municipalities directly administered by the central government, up from 158, or 4.16 percent. According to a separate sample survey, 60 percent of R&D institutions under state organs above the county level have now implemented the director responsibility system and 61 percent have put into effect or are putting into effect a professional and technical position appointment system.

2) Extensively offering scientific and technical services to society and the economy. To adapt to the development of the national economy, R&D institutions in all industries have been undergoing structural adjustment. During the period 1979 to 1986, R&D institutions under state organs above the county level increased their scientific and technological personnel by 10.8 percent each year on the average. The increase was particularly fast in raw materials and electronics industries, where the growth rate exceeded the national average, and was slower in the ferrous metal industry and post and telecommunications. The proportion of scientific and technological personnel dropped from 21.9 percent to 19.5 percent in the lumbering industry, agriculture, and the extraction of natural resources; increased from 8.2 percent to 12.1 percent in the raw materials and primary processing industries; decreased from 22.3 percent to 20 percent in the chemical, plastics, and machine-building industries; rose from 3.5 percent to 4.4 percent in the electronics and instrument and meter industries; and decreased from 4.7 percent to 2.9 percent in post and telecommunications. These shifts are basically consistent with present social and economic developments and set the stage for future development.

The following data reveal from a number of angles the contributions made

by China's R&D institutions to scientific and technological progress. At present, over 5,000 technical trading organizations above the county level have been established, their combined value of business rising from 50 million yuan in 1983 to 2.06 billion yuan in 1986. R&D institutions under state organs above the county level and institutions of higher education did 901 million yuan and 133 million yuan worth of business, respectively, in 1985. The figures for 1986 were 710 million yuan and 110 million yuan, respectively. Apart from promoting developments in agriculture, forestry, and fishery and in industry (transfer of technology amounting to 8.8 percent and 54.1 percent, respectively,) such technology transfer has also fueled developments in energy, transportation, and communications (accounting for 7 to 9 percent of total value of technology transfer) and stimulated developments in public health, social services, environmental protection, and other public-welfare undertakings (3 to 4 percent of total value of technology transfer.) It has contributed to collective and township and town enterprises (6 to 8 percent of total value) as well as enterprises owned by the whole people (73.5 percent).

Along with the dissemination of knowledge and technology, their vehicle--scientific and technological personnel--also became increasingly mobile. In 1985 and 1986, 2,759 and 1,477 scientific and technological personnel, respectively, from R&D institutions under state organs above the county level found their way into enterprises, while 1,938 and 3,771 people moved into state organs and institutional units, respectively. The overall mobility rate was 3 to 5 percent. Furthermore, there are large numbers of scientific and technological personnel who work part-time or who have been appointed technical advisers. Some retired scientific and technological personnel have also made definite contributions to society.

In the past few years, certain R&D institutions have strengthened ties with the economic sector as well and have merged with or are merging with an enterprise or group of enterprises. Some have formed scientific research-production-sales and marketing companies for an industry or region and some have undertaken to provide technical direction and services to an enterprise. Over time this kind of linkage or cooperation has become permanent and stable. According to statistics, by 1985 24 percent of R&D institutions under state organs above the county level had established relatively long-range scientific research and production associations with enterprises and 22 percent had undertaken to provide technical direction, consulting, training, and testing services to enterprises on a long-term basis. In 1986, about 10.4 percent of the development projects of large and medium-sized enterprises were undertaken in cooperation with R&D institutions. Another sample survey shows that approximately 40 percent of all R&D institutions under state organs above the county level had created linkages of all description with enterprises. Of these, 9 percent have merged with an enterprise or a group of enterprises, 35.5 percent have become technical centers for a particular industry or region, and 5.1 percent have absorbed enterprises into them forming scientific research production companies.

3) The self-development capacity of R&D institutions is on the rise. Statistically, the lateral income of R&D institutions under state organs above the county level reached 2.76 billion yuan in 1986, up from 1.05 billion yuan in 1984, for an average annual increase rate of 62 percent, far higher than the average annual growth rate of 16.9 percent for government appropriations during the same period. The lateral income of scientific and technological personnel rose from 2,383 yuan in 1984 to 5,290 yuan in 1986, for an average annual increase rate of 49 percent. Of lateral incomes, technical incomes accounted for 59.8 percent in 1986, up from 42 percent in 1985, which testifies to the improvement in their self-development capacity. Comparatively, R&D institutions under municipalities directly administered by the central government and those under various State Council ministries or commissions earn more or less the same amount of lateral incomes, but while the former's technical incomes rose by 28.8 percent, the latter's shot up 52.3 percent, which proves the latter's stronger technical development capability. In a separate sample survey, 56 percent of the nation's R&D institutions had instituted topic contracting or partial topic contracting by the first half of 1987, and a small number were even experimenting with collective or personal contracting, proof that their operational and management level had gone up.

3. The Enormous Contributions Of Scientific And Technological Work

Reform and opening up have facilitated the conversion of China's scientific achievements into productive forces. Between 1979 and 1985, a total of 39,552 major scientific and technical achievements at the national level were completed. Between 1979 and 1986, 2,998 items were awarded the national scientific and technical achievement award. The multiplication of achievements has far outpaced that of the increase in scientific and technological resources. Since China began handling patent applications in April 1985, it dealt with 32,881 applications within 1 and a half years, of which 23,091 were Chinese inventions. Of the 3,162 patents granted, 2,782, or 88 percent, were domestic. According to statistics from 23 provinces, municipalities, and autonomous regions and 18 organizations under the State Council, there were altogether 98,245 scientific achievements in China during the Sixth 5-Year Plan, of which the shares of R&D institutions and institutions of higher education were 32 percent and 10.6 percent, respectively. Of the total number of achievements, 2,834, or 5.3 percent, were international firsts and reached advanced international standards, 2,834 (or 2.9 percent of the total) won national awards, and 41,706, (42.5 percent of the total) won provincial or municipal awards. Of the 937 national invention awards, R&D institutions and institutions of higher education accounted for 54.8 percent and 21.6 percent, respectively. Of the 125 national natural science awards, their shares were 64.8 percent and 35.2 percent, respectively. Thus we can see that their contributions are immense.

In 1986, the nation's R&D institutions under state organs above the county level completed 37,000 scientific research topics, of which 35,300 were disseminated and applied. Of the latter number, 18,800

topics, or 50.7 percent, produced social benefits and 16,600 topics, or 44.7 percent, generated economic benefits. The institutions published a total of 69,200 scientific papers, including 5,706 published overseas (8.2 percent). Published scientific and technical writings amounted to 631 million characters, 2.5 percent of which had been translated into foreign languages and 5.5 percent were used as teaching materials in institutions of higher education. Of the 6,812 scientific achievements from institutions of higher education that were evaluated, 912 were considered to have reached international standard. The institutions of higher education published 80,000 scientific papers, including 5,556 (or 6.9 percent) published abroad. Their published scientific and technical writings amounted to 1.23 billion characters. All this has enriched China's treasure trove of knowledge.

Of the 98,245 achievements obtained during the Sixth 5-Year Plan, 6,315 were theoretical achievements and 91,930 were technical achievements, 6.4 percent and 93.6 percent, respectively, of the total. Of this total, 64,017 achievements were disseminated and applied, 69.6 percent of all technical achievements. According to incomplete data, the 937 achievements that won the national invention award during the Sixth 5-Year Plan increased earnings and cut costs to the tune of over 30 billion yuan in all. Among them were 32 achievements which each accounted for more than 100 million yuan, increasing earnings and cutting costs by a total of 26.6 billion yuan. The 1,772 achievements that won the national scientific and technological progress award increased earnings and cut costs to the tune of 76.5 billion yuan. This shows that R&D has brought clear social and economic benefits to the nation.

4. Thoughts On Future Developments

1) The intensity of scientific and technological inputs. In the context of overall national economic development, how much S&D inputs are optimal? What would be the optimal resource allocation plan? To answer these questions, we must first take a look at the development trends in the world today. (See Tables 1 and 2.)

We can see from Tables 1 and 2 that in some developed nations, R&D spending all increased at a faster rate than the GNP. This statistical pattern was crystallized in the changing ratio between R&D spending and the GNP and that between R&D spending and the national income [NI] (see Table 3.)

Through analysis, we can see that the overall trend in those nations is toward the diversification of R&D investments. Government investments in R&D have been growing slightly less rapidly than R&D spending as a whole.

We can also see that in all these countries, government investments in R&D take up a steadily rising share of total government spending. In the FRG, for instance, the ratio was 3.4 percent in 1985, up from 2.1 percent in 1962. Our statistical work at the moment is imperfect, but

what data we do have suggest that R&D spending in China not only pales in absolute terms in comparison with that in developed nations, but also trails them in increase rate and relative to the major economic indicators. For example, between 1979 and 1985, both gross value of industrial and agricultural output and national income expanded by an average annual rate exceeding 12 to 13 percent, calculated in prices for the year concerned (7 to 9 percent between 1979 and 1983), while R&D spending by the state grew by a mere 6.17 percent annually on the average between 1979 and 1983.

2.) Mix of scientific and technological resources. In China's scientific and technological system, scientific and technological resources are mainly concentrated in R&D institutions under state organs, whose funding constituted about 59.84 percent of all R&D funding presently included in our statistics and who employ 53.49 percent of all scientific and technological personnel. In contrast, large and medium-sized enterprises account for only 37.99 percent of R&D funding and 35.29 percent of the scientific and technological personnel. This pattern of distribution of scientific and technological resources along with the status quo in which most R&D institutions remain aloof from the economy of enterprises has severely prevented the improvement of

Table 1 A Comparison Of GERD [general expenditures on R&D], Increase Rate, and Economic Growth in Various Nations (%)

	U.S.	FRG	Japan	France	Britain	USSR
Years	'65-'85	'65-'85	'65-'84	'65-'82	'65-'83	'66-'83
GNP	9.05	7.19	11.94	12.43	12.50	6.15
NI	8.87	7.01	12.00	12.25	12.25	6.03
R&D Spending	8.83	9.90	16.03	12.69	12.39	7.84
govt.inputs	7.06	8.92	13.66	11.14	12.33	6.23
Increase rate						
GERD:GNP	-0.22	2.71	4.09	0.26	-0.11	1.69
GERD:NI	-0.18	2.89	4.03	0.44	0.14	1.81
Govt.Input: GNP	-1.99	1.73	1.72	-1.29	-0.17	0.08
Govt.Input: NI	-1.81	1.91	1.66	-1.11	0.08	0.20

NI= National income
Note: Data in table calculated in country's currency using current prices

Table 2 Per Capita R&D Spending and Increase Rate in Various Nations

	U.S.	FRG	Japan	France	Britain	USSR
Years	'65-'84	'67-'81	'65-'84	'66-'83	'72-'81	'65-'84
Funding per scientist/engineer						
	$40,533.9-	DM136,973-	Y3,621,200-	Fr225,365-	17,504.6-	R10382.2-

	129,579.1	299,239	19,393,600	913,565	62001.1	18855.0
Average annual increase rate						
	6.31	5.74	9.23	8.58	15.1	3.2
Funding per capita						
	$103.2-411	DM147.5-621.9	Y4333.1-59687.4	Fr219.6-1541.2	L24.28-105.02	R30.05-100.8
Average annual increase rate						
	7.54	10.82	14.8	12.14	17.7	6.6

Note: In 1986, R&D funding per scientist/engineer in R&D institutions was 30,700 yuan in China, equivalent to one-tenth to one-third that of the U.S., FRG, France, and Britain, one-eighth that of Japan, and one-half that of the Soviet Union.

Table 3: R&D Spending And Its Share Of GNP and National Income in Various Nations (%)

Country	Years	GERD as % of GNP	GERD as % of NI
FRG	1965-1985	1.70-2.80	1.91-3.25
Japan	1965-1984	1.27-2.37	1.61-2.99
France	1985-1982	2.02-2.10	2.23-2.38
USSR	1966-1983	2.85-3.73	3.57-4.85
U.S.	1965-1985	2.83-2.73	3.09-3.06
Britain	1965-1983	2.34-2.18	2.55-2.47

economic returns. It should be seen that scientific and technological progress in society not only depends on those which create science and technology, but is also constrained by one environmental factor--the receiving end. Therefore, it would benefit China's technological progress and economic growth for us to learn from the experience of developed nations and overhaul the entire economic structure, including industrial structure, product mix, technological structure, and the mix of capital inputs.

3) Scientific and technological reserves. According to 1985 statistics, short-term R&D projects, those lasting less than 3 years, accounted for 72.9 percent and 88.7 percent of projects undertaken by R&D institutions under state organs above the county level and by large and medium-sized enterprises, respectively. Ultra-short projects lasting less than 1 year accounted for 26.7 percent and 56.9 percent of the projects undertaken by R&D institutions under state organs above the county level and by large and medium-sized enterprises, respectively. Short-range projects pay off rapidly, but short-term behavior affects the momentum for development. According to a separate study undertaken by R&D institutes under state organs above the county level, basic research accounted for about 2.6 percent, applied research, 7.5 percent, and experimental development, 21.3 percent, whereas topics devoted to knowledge dissemination and application accounted for 68.6 percent. China is a developing nation, so its emphasis on applied technology only reflects

market demand. Out of long-term considerations, however, China has no choice but to take care to step up creative activities and emphasize scientific and technological reserves.

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Economic Growth Contingent on Scientific Progress

81112833c Beijing ZHONGGUO KEJI LUNTAN [FORUM OF SCIENCE AND TECHNOLOGY IN CHINA] in Chinese No 2, 1988 pp 13-15

[Article by Liu Zhong]0491 0112]: "Stages in Scientific and Technological Development in China"]

[Text] 1. Economic growth, to a large extent, is determined by scientific and technological progress. To accelerate scientific and technological development in China, we need to evaluate correctly the position and functions of science and technology in the national economy and its changes and trends in order to identify the major contradictions in its development. And before this can be accomplished, we must fully understand the characteristics of China's national conditions.

Since the 13th NPC, people have gradually realized that what characterizes the current state of China is the fact that it is in the primary stage of socialism. The principal contradiction in China's society and economy during this stage is that between existing production relations, which are largely socialized, and backward productive forces. This important contradiction dictates the present state of various aspects of social economic life, including science and technology.

The relative backwardness of China's productive forces manifests itself mainly in the following ways: 1) China's labor productivity is only about one-tenth that of some developed industrialized nations. Agricultural production essentially remains manual labor. Industrial technology trails that of other nations by 10 to 20 years, even longer in some industries. The industrial structure is highly irrational and the circulation channels are grossly underdeveloped. 2) China ranks at the bottom of the world in the volume of material goods per capita. While we have preliminarily solved the problem of hunger and clothing, there is still a gap between the improvement of the quality of life and economic development, which has constantly plagued economic development. 3) Low management standards. Not only do we lack experience in mass social production, but we also are deficient in our knowledge of commodity production and inapt at operating in accordance with economic

principles and deploying all kinds of economic levers. Our policies are also of a poor quality and have a penchant for pursuing extensive production. 4) The poor caliber of the labor force. We lack large numbers of skilled technical workers and scientific and technological personnel. The shortage of technical personnel at the first front of engineering is particularly acute. 5) Society as a whole has yet to break out of its isolated state. The traditional idea of small production is still a powerful constraint on economic development. The role of science and technology and scientific and technological personnel has not received sufficient attention from society.

2. The primary stage of socialism is a fairly long historical stage. Is is a historical inevitability dominated by the development of productive forces. When we draw up scientific and technological development principles and plans, therefore, we cannot avoid the basic social reality, namely that our top priority now is to develop productive forces. We must understand fully and reckon the long-term impact of this major contradiction on scientific and technological development and hence project that as social productive forces gradually increase, scientific and technological development in China may go through a number of different stages, each with its special historical mission, which we must accomplish, and special problems, which we must solve.

1) The beginning, that is, the stage when a foundation is laid for the entire scientific and technological enterprise. Its main characteristics are: 1) The kind of stable and normal social, political, and economic environment required by scientific and technological development gradually takes shape. However, there remains much man-made and unpredictable interference in the external environment; 2) The scientific and technological management system is being institutionalized step by step, but the overall development of science and technology remains exploratory. 3) Scientific and technological work itself is in a capital construction stage, with human, financial, and material resources being accumulated and amplified. A major problem is limited scientific and technological inputs and lack of diversified channels. 4) Given insufficient scientific and technological forces, the scope of work cannot be too expansive. The emphasis will be on defense, agriculture, public health, and other major areas and priorities. Application and dissemination covers a large area and the kind of advanced technology required by national economic development will mainly come from abroad. Because of these reasons, national economic development will mainly follow a quantitative (extensive production) pattern, resulting in frequent incompatibilities between scientific and technological work and economic work and hurdles in the conversion of scientific research achievements. All this should command full public attention.

2) Developmental stage. This is the stage when the value of science and technology is affirmed and realized. Its major characteristics are these: 1) The rudiments of a normal social, economic, and political environment are in place. 2) The scientific and technological management

system is gradually being standardized.3) Capital construction in science and technology comes to an end. A scientific and technological contingent of a fairly high standard has been put together and a multi-level and multifaceted scientific and technological network has come into existence. For a variety of reasons, though, informational channels will not be too smooth. 4) Scientific and technological inputs have reached a certain magnitude and new channels are being opened up, but there is still some way to go before the needs of large-scale basic research can be met. Apart from increased state investment in R&D, the solution is to tap new investment sources and create new risk takers. 5) As a result of international competitive pressure and China's limited resources, the national economy will gradually shift from the quantitative mold to pursue efficiency. The tangible manifestations of such a shift will be the increasing demand by enterprises for technological advances, which will be conducive to the conversion of scientific achievements. However, still lacking are more positive international and external environmental factors and conditions that favor risk-taking. These characteristics require continued efforts to step up scientific and technological work and turn scientific achievements into productive forces as soon as possible in order to establish a feedback-stimulating input-output relationship between science and technology, on the one hand, and the economy, on the other, that will contribute to macroeconomic performance.

3) The flourishing stage. By now the national economy has become much stronger. The bulk of scientific and technological inputs have been transformed substantially. Financial, human, and informational resources are fairly adequate and basic research has been made a priority. As the commodity economy develops, competitive mechanisms are introduced, the division of labor in specialized production and the management system are perfected, and cooperation between enterprises and the scientific and technological community is closer, greatly accelerating the industrialization of scientific achievements. A host of scientific and technological enterprises spring up continuously and science and technology becomes the main driving force of social development. Meanwhile, the value and social position of scientific and technological personnel will be generally recognized and technical gaps between regions and industries will be narrowed. The main problem of this period is the proper selection of scientific research topics that will have a profound impact on the national economy, technical appraisal, and the development of large-scale international scientific and technological cooperation and exchange.

We should adopt different development principles for the different stages mentioned above. Since a good foundation must be laid in the beginning, we must rely on state support. Depending on needs and capabilities, scientific and technological institutions should be set up at various levels, a scientific and technological contingent should be put together, information should be gathered, experience should be acquired, the management system should be perfected, a number of scientific and technological tasks urgently needed by the national economy should be undertaken, and achievements should be disseminated.

The key is to ensure that scientific and technological inputs go up steadily, qualified personnel are trained, and basic scientific and technological construction is completed. After entering the developmental stage, the scientific and technological sector must effect the shift from accumulation to the release of resources, so the crux of this stage is the creation of a feedback-stimulating relationship between scientific and technological inputs and economic growth. During this stage, we must come to grips with the central link of converting into productive forces scientific achievements of decisive significance for industrial and technological progress so that limited inputs are used at the cutting edge to promote macroeconomic growth: the adjustment of the industrial structure, the technological development of enterprise groups, import substitution, and export substitution, among others. To accomplish this task, we need the guarantee of a scientific and technological program consistent with the direction of national industrial structural adjustment and the guarantee of managerial mechanisms. The state will make the R&D of applied technology its focus in scientific and technological work, particularly the redevelopment of imported technology. In view of the fact that the value and status of scientific and technological work will largely be determined by its contributions to national economic development, the scientific and technological sector must take the initiative to convert their achievements extensively in order to establish its role and position in social economic development, thus making China a nation "founded on technology." Certainly, to achieve the objectives of the developmental stage also depends on a shift in the national economy toward efficiency, the penetration of competitive mechanisms into every part of social economic life, the extent of openness to the outside world, and the replacement of the state by enterprises as the main provider of scientific and technological inputs. In the flourishing stage, a fully mature market is in place to provide an extensive range of research topics and sufficient funds for scientific development. The bulk of scientific and technological inputs during this stage will come from enterprises while state investments will concentrate on exploratory topics on the cutting edge, essentially supporting basic research, and provide the necessary social services and safeguard measures for all kinds of research.

3. The continuing shift in the thrust of scientific and technological work in China will expedite a series of changes, as follows: 1) The development of scientific and technological institutions will bring about a change from dependence on the state to self-improvement to reliance on enterprises; 2) The main source of scientific research topics and funding is now the state plan. That will be diversified to include a multitude of channels, particularly enterprises and financial institutions; 3) The emphasis in research achievements will be on social economic value instead of academic value; and 4) The focus of scientific research work will take a circular pattern, from applied basics through R&D and the industrialization of technology to basic science. Effecting the above-mentioned changes is what scientific and technological structural reform is all about. In the final analysis, we must judge the

success or failure of the reform by the presence or otherwise of coordinated development between science and technology, on the one hand, and the economy, on the other.

Scientific and technological structural reform is a process whereby science and technology and the economy interact with and penetrate into one another as well as a process of adjusting the operating mechanisms within science and technology itself. It follows that strengthening consultation and dialogue among different fields will provide ideas for policy-making by the other side.

The substance of scientific and technological structural reform mainly covers the following aspects:

1. Improving the quality of scientific and technological managerial cadres at all levels and enhancing their reform consciousness. They should be required to inform themselves of the economic development situation and the state of economic reform and hence develop a sober appraisal of the objective environment of scientific and technological structural reform and be ready at all times to solve the key problems in the coordinated development of science and technology and the economy. Even as they vigorously pursue all sorts of reform, they should take care to maintain the relative stability of reform policies and measures to reduce unnecessary traumas and reversals to a minimum.

2. Introduce competitive mechanisms into the internal management of scientific and technological institutions and reform the appropriations, achievement evaluation, personnel administration, and wage systems in scientific research. Launch a technology development contracting responsibility system across the board to relate the efficiency of a unit to its wages. Vigorously carry out pilot projects in the separation of ownership from management. Mobilize the initiative of scientific and technological personnel and improve their work efficiency by integrating responsibilities, power, and interests. Reorganize, contract, lease, and even auction off those units that are patently mismanaged and grossly inefficient.

3. Extensively publicize the developmental theory that science and technology and the economy must be mutually dependent to make scientific and technological personnel pay attention to the conversion of achievements. Create miscellaneous conditions and formulate coordinated reform measures to attract large numbers of scientific and technological personnel to go into economic construction and nurture a host of scientific and technological entrepreneurs.

4. Review the organizational reform experience of scientific research units promptly. The best way to end the fusion between government and enterprises and between government and research in management is to overhaul the functions of government departments in charge. As for the entry of scientific research institutions into enterprises, we should not see it simply as an institutional merger. Instead we should promote flexible, diversified formats. For example, a research institute may

merge with a group of enterprises, lease and contract to run all kinds of enterprises, or contract for the technological development of an enterprise or group of enterprises. Another possibility is for individual research offices or sections to contract for the technological development of an enterprise. In short, we must not confine ourselves to just one form of administrative subordinate relationship. Instead we should gradually create a range of scientific research entities of a commercial nature through practice.

5. Guide scientific research institutions to abandon the pursuit of microeconomic benefits for their own units in favor of that of macroeconomic interests. What some research institutions do to improve themselves these days should be regarded as a sign of the underdevelopment of socialization and the specialized division of labor. As the reform macro-climate changes, so will this phenomenon. Regarding scientific research institutions already on their own today, we should adopt a long-term deregulation policy and encourage them to develop in a direction consistent with the industrial structural adjustment by the state, support the technological progress of groups of enterprises, actively participate in the absorption and assimilation of imported technology and do their best to contribute to the development of China's emerging high-tech industries.

6. Vigorously promote the mobility of qualified personnel. The mobility of qualified personnel involves the socialization of their utilization and management and is conducive to the conversion and appreciation of scientific and technological achievements. Thus we must create for it a relatively favorable social environment. As we reform the housing, permanent residence, personnel, wage, labor insurance, and other systems, we should try to bring about conditions favorable to the mobility of qualified personnel to encourage them to do their part where they are most needed in the national economy. Within a certain period of time, we may advocate the mobility of experts using various forms of contracting. In areas with roughly the same level of development, units may experiment with the free appointment of personnel. When the regulation of qualified personnel is truly over, it will signify success in coordinated reform.

7. Put an end to the lack of variety of scientific and technological inputs. On the one hand, we must economize by cutting back on operational expenses. On the other hand, we must open up new funding channels through reform and establish a new risk-taking system, such as setting up engineering investment companies to attract the participation of banks and insurance companies and issuing stock or bonds to socialize the risk of investment. In addition, we must offer insurance at different stages of technological development to risk-taking investors in order to speed up the industrialization of achievements.

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The Case for Enterprise Incubators in China

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[Article by Huang Shengli [7806 0524 0440]: "China Should Learn From the West in Setting Up Enterprise Incubators"]

]Text] Enterprise incubators are also known as "enterprise nurseries" and "scientific and technological innovation centers." It is hard to give it a precise and permanent definition. Enterprise incubators belong to the lower level of high technology and are regarded as the principal instrument for the development of science parks and scientific and technological industrial parks. In Europe and the U.S., many enterprise incubators exist independently on their own. While every incubator has its own functions and goals, they are similar in that like hens hatching chickens, they incubate "eggs" (embryonic technological organizations or companies) into "chicks" and then nurturing them into "chickens" (high-tech companies). An incubator provides the technological company or organization a place to work in return for a relatively cheap rent and the necessary venture capital, assists it with industrial or commercial registration, tax registration, and patent application, and offers a range of consulting services in legal, financial, accounting, information, and marketing matters and in business management. This comprehensive range of services lowers the costs and risks of founding a business and provides a microclimate favorable to a scientific entrepreneur as he tries to set up a business. The basic objective of an incubator is to expedite the conversion of scientific achievements into products and the development of technology-intensive industries and enhance the competitiveness of the nation's high tech. Incubators in Western Europe were modeled on the Silicon Valley in the U.S.

There are currently 165 enterprise incubators in Western Europe and 209 in the U.S., the latter projected to reach 1,000 by 1990. With its well-established and massive technological industries, why is there still a need for enterprise incubators in the U.S.? A possible conclusion is that in the future high-tech industries will be concentrated in small and medium-sized clusters; people are no longer willing to invest 30 years to build a new "Silicon Valley." As a special means of developing high-tech industries, enterprise incubators

naturally get their fair share of social attention.

As far as China is concerned, it is not only necessary but also possible to establish enterprise incubators. Scientific, technological, and economic reforms in China have made considerable headway. Political structural reform is under way actively. In the transitional period between the old and new systems, however, a number of longstanding social economic problems have yet to be resolved satisfactorily. For instance, enterprises have not developed technical innovation mechanisms. Their ability to absorb and develop new high tech remains fragile, resulting in a lack of sustained developmental drive and difficulties in adapting to the needs of market competition. Research institutes still lack R&D capacity and the vigor to convert scientific achievements into products. Things are even harder for intermediary organizations. In Shenzhen, for instance, over 70 technical consulting companies have successively left their field and switched to trade. The establishment of incubators, therefore, has positive and practical significance for China's science and technology and economy. It can target problems in the primary stage of socialism, train a solid contingent of entrepreneurs of the scientific mold, spur the development and flourishing of research institutes founded by private individuals or enterprises, promote the integration of scientific research with production and marketing, speed up the marriage between science and technology and the economy, and accelerate the intensification of reform. In setting up an incubator, for instance, we will necessarily touch upon some sensitive areas in the reform of personnel management, finance, and legislation, thereby quickening the solution of some issues. State legislation and rules on private scientific enterprises may also be prepared more rapidly.

In a field study, we found that science and technology commissions in such places as Shenzhen, Guangzhou, and Wuhan have actually begun making preparations vigorously. Both the Guangzhou Science and Technology Development Corporation and the Wuhan Donghu Center for New Technological Entrepreneurs have started to function like enterprise incubators in some ways. We may argue that the design and preparatory stage of incubators is already under way. The following proposals are put forward for reference by the parties concerned:

1. In the preliminary stage, incubators should be government-run or have a heavily official character. Otherwise they will find the going very rough under present circumstances. Certainly the general principle that incubators are run by society with government participation should be made clear as early as possible. As the situation develops and the environment or conditions change, incubators would be jointly run by the government and the private sector or privately-run with government assistance. This is because an incubator run by the government alone is apt to become operationally and managerially rigid. Moreover, this will add to the burden on the state and affect the incubator's developmental momentum.

2. Based on an analysis of our research findings, the biggest impediment

to the establishment of enterprise incubators at the moment remains the personnel management system. Many scientific and technological personnel branching out on their own to found a business are under pressure from their units who want to force them back into the fold of the "iron rice bowl" by threatening to take back their quarters, take disciplinary action against them, demote them, and recover training costs, etc. Denied permission to resign, some scientific and technological personnel had no choice but to ask to be dismissed, only to be turned down also. We believe that the major problem right now is not the reluctance of large numbers of technological personnel to take the entrepreneurial road for fear that there would be no way out. This is because one must be prepared for all the consequences of failure if one is to be an entrepreneur and that it would not be practical for the state to assume the risks. The main concern is for the state to formulate and promulgate personnel management policies as soon as possible to provide incubators a level of management and management assistance in such matters as personnel, record-keeping, technical job classification, and organizational relations. Once this is sorted out, everything else will fall into place.

3. The state should replace policies with legislation by working out laws and regulations governing private scientific and technological enterprises without delay, such as a private enterprise management law, etc, so that enterprise incubators and private scientific and technological enterprises have a legal basis and can develop smoothly. In neither policy nor law-making can we rely on local initiative alone for these reasons: 1) If there is no one uniform policy, there can be no uniformity in implementation. The documents of the Shenzhen municipal government, for instance, have binding force on units or departments outside the municipality. Yet most founders of private scientific and technological enterprises come from units and departments outside the municipality. 2) Policies serve as a guide and are not mandatory. It is possible not to enforce them. 3) Local policies cannot reconcile regional, personal, and national interests. For instance, people who want to strike out on their own as entrepreneurs are usually their units' mainstay workers, capable, socially well-connected, and adept at business. Whether or not they decide to stay in their original units directly affects the interests of the department or region they are originally with. This is a matter that needs to be studied in depth and carefully handled.

4. Pay attention to the factor of people. Enterprise incubators should have qualified business personnel, market analysis personnel, R&D personnel, legal consultants, banking experts, and even marketing experts. Therein lies the key to success. Besides technical and economic insight, initiative, and a spirit of adventure, people who operate enterprise incubators must have a strong aptitude for public relations. This is vital. Our study on private scientific and technological enterprises shows that successful enterprises have invariably established good relations with the quarters concerned (including the units they were originally with), and obtained powerful support from them.

5. Start an enterprise with hard work and thrift, make do with whatever is available, and avoid extravagance and the penchant for large-scale capital construction and equipment acquisition. In the early developmental stage, enterprise incubators should opt for leasing, joint operation, and other forms as much as possible instead of building their own facilities in order to maintain sufficient working capital and reduce risks to a minimum. Wuhan University, for example, has 100 assorted laboratories but shows no interest in leasing them. One of the functions of an enterprise incubator is exactly to connect and smooth out this kind of channel to provide work sites and intermediate testing conditions, etc. To build everything oneself is a form of self-isolation in itself.

6. Enterprise incubators should have a capacity for risk investment, such as the investment of "seed money." At the same time, for financial institutions and private scientific and technological enterprises entering an incubator, an incubator is also a middleman which guarantees loans without directly taking part in lending and credit activities. At present, private scientific and technological enterprises have difficulties obtaining credit. Many enterprises experience cash flow problems. Some have no alternative but to borrow from other enterprises. While such borrowing is formally known as cooperation, the lender often charges as high a monthly interest rate as 1 percent. This directly undermines the survival of private scientific and technological enterprises. Besides the institutional limits of financial institutions, their policy worries and their lack of confidence in the future of private enterprises, other important factors are such enterprises' own meager ability to take risks and make repayment. Thus, state risk investment organizations should consider shifting the thrust of their work toward incubators. In addition, whether to support development or to take part in guidance, the state should devote a certain percentage of inputs to incubators, stressing loans (including low-interest loans and loans at subsidized interest rates) and down-playing appropriations. This too will fully mobilize local initiative. The scale and proportion of inputs should be determined by the incubator's macro-development strategy.

7. Enterprise incubators are enterprises as well as comprehensive service and management entities. More often than not, their relationship with the incubated is a cooperative one, not simply that between a department in charge and a subordinate unit. As for how they actually cooperate, that should vary with local conditions. Apart from entering an incubator and be incubated, a private scientific and technological organization can also sell patents, go in for technical transformation, exchange technology in return for stock in a company, or build a factory as a joint venture. Such entry can take a variety of forms at different levels. The last thing we want is a set mold.

8. Industry and commerce departments should be reasonably flexible when reviewing registration applications. At present, some localities define areas of operation in far too elaborate detail and stick to them rigidly

(those who make radio cassette recorders cannot make video cassette recorders) and even regulate the specifications and model type of a product. Such practices should come to an end. It is inconsistent with the characteristics of a commodity economy to control the type of products an enterprise makes too closely. Certainly, limits should be imposed on the extent to which an applying organization can go inter-industrial so as not to affect its high-tech innovative abilities.

We should take pains to control the extent of risk-taking in the actual operations of an incubator. It is true that the higher the risk, the greater the profit, but to put themselves on a solid footing, incubators tend to steer clear of the unknown in favor of the tried and true in order to make a fast buck. They may, for instance, be overly selective in accepting private scientific and technological organizations who want incubation,, overemphasize applied technology or technology already developed, or go after projects that require little inputs and pay off quickly. All this should be permissible for an incubator in its infancy. When an incubator reaches a certain stage of growth, however, it should guide scientific and technological organizations toward high tech and actively develop new technology. It should not be content with doing coordinating work to fill gaps in and service domestic technology and large products. An effort should be made to constantly stimulate an incubator's sense of innovation and innovative behavior. Otherwise, the result will not be a cluster of high-tech enterprises, only a concentration of run-of-the-mill scientific and technological production units. The primary method of lowering risk is to improve the accuracy of market forecasting and assessment.

It has been merely 10 years since enterprise incubators first appeared and they are still maturing and improving. They are a novelty in China. In their early stage, therefore, the localities would do well to plan comprehensively and take a gradual cautious approach by combing specific local conditions with special authority and preferential policies. They should learn from the Western European experience and avoid having overly high expectations or succumbing to the herd instinct, which will not do the healthy development of enterprise incubators any good.

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Reasons for Slow Technological Progress Given

81112833e Beijing ZHONGGUO KEJI LUNTAN [FORUM OF SCIENCE AND TECHNOLOGY IN CHINA] in Chinese No 2, 1988 pp 32-35

[Article by Zhang Amei [1728 7093 1188], Gao Liang [7559 2733], Wu Xin [2976 2946], Gu Libing [6253 4539 0393], and He Liren [0149 4539 0086]: "Economic System a Barrier to Technological Progress"]

[Text] 1. Let's begin with the contradictions in China's industrial structure.

First, the stagnation in basic raw materials industries and the rapid expansion in the assembling, processing, and daily consumer goods industries have resulted in blockages in technology conduction.

The results of a survey on the growth rate in 20 industries in China show that while basic raw materials industries languish, processing, assembling, and daily consumer goods industries are expanding rapidly. Under a normal price system, when one kind of industry grows much more rapidly than another, the fundamental reason is that technological progress and accumulation proceeds at different speeds in the two industries, creating different receptiveness to innovation.

What then accounts for the fact that the growth rate in upstream industries trails that in midstream and downstream industries? From the perspective of technological progress, there are at least these two reasons:
1. The external migration of demand. As things now stand, the higher an industry's external forward linkage, the greater its share of foreign trade. For instance, the ferrous metal industry accounts for 24 percent of net imports, nonferrous metal industry, 18 percent, and heavy and chemical industries, 13 percent. This shows that imports greatly influence the formation of industrial linkages in China. When the purchasing power of midstream and downstream industries is partly shifted outward, it is tantamount to giving up the domestic market of the required inputs, that is, giving up demand. When the demand in midstream and downstream industries moves overseas, the stimulating signals of the market to upstream industries is weakened. The structural rigidity of the upstream industries themselves, moreover, often slows down their rate of technological transformation compared to

that of midstream and downstream industries, leading to a much slower growth rate relative to the latter industries.
2. Technological progress in upstream industries has a relatively high "threshold." Midstream and downstream industries, particularly light, textile, and machine industries, are amenable to small-batch production and can be operated on a small scale. Entry into these industries is easy for the existing level of technology in China. Miscellaneous collective enterprises and township and town enterprises, in particular, are well suited to these industries. In contrast to the competition in midstream and downstream industries, a state-imposed monopoly remains in most upstream industries. If we say that the drive for technological progress is stronger in midstream and downstream industries in a period of expansion as a result of heightened interest stimulus and market competition, then the impetus for technological progress in upstream industries, where a seller's market has prevailed for years, is relatively weak because of an inability to end a monopoly born of scarcity.

All this results in slow growth in upstream industries and much faster growth in midstream and downstream industries. The upshot is that shortages remain and surpluses worsen. Improvements in supply in upstream industries are a long way from keeping up with changes in midstream and downstream industries.

Second, poor compatibility between the internalized structure and the original industrial structure.

As the extent of openness increases, not only does the supply of upstream industries become dependent on foreign exchange to a large degree, but the growth of downstream and midstream industries will also become more and more interwoven with international trade. It is almost impossible nowadays to find a part in any industry or sector in China untouched by international trade. Import, in particular, represents a new economic activity. It constitutes a new economic structure different from the existing one.

However, because of poor compatibility between the internalized structure and the original industrial structure, when the assimilation and absorption of imports encounter the barrier of low efficiency or inefficiency, domestic products will be hit increasingly hit by imports. At that time technological conduction will be severely hampered.

2. A Preliminary Analysis Of China's Technological Progress Mechanisms

From the perspective of economic growth, the translation of technology from potential elements of production into actual productive forces must go through a number of stages, from research and application to development and dissemination. The shorter the cycle, the fewer the obstacles, and the fewer the obstacles, the greater the economic benefits. Based on the experience of most developed nations in economic growth driven by technological progress, competition, monopoly, and state intervention are the main forces of technological progress.

Competition propels producers with new technology to innovate continuously. Monopoly affords competition a certain organizational guarantee. State intervention determines the direction of technological progress.

China's present technological progress mechanisms combine the characteristics of an underdeveloped economy with those of a "centralized" economy. An underdeveloped society undervalues intellectual products and the labor of intellectuals, making it immensely difficult to transfer technology with compensation or to form a technology market. The traditional slight for commerce, passed on from generation to generation, hinders the development of a commodity economy and creates a psychological block among the talented and gifted, who feel it beneath their dignity to go into business. Because the country is backward, there is an inferiority complex about indigenous technology and domestic products, thus worsening the dependency on imported goods and technology. As a result, import substitution has "lost steam." All these are negative factors related to underdevelopment that are affecting technology conduction and technological progress.

The effects of the economic system on technological progress are even more involved. While it is in the midst of radical change, the economic system still keeps many of its old shortcomings, which have proved most obstructive of technological progress and conduction. From the economic angle, such obstruction manifests itself mainly in the following ways:

1. The most important production evaluation criteria for an enterprise are output and output value. Stringent evaluation hampers the effort of the enterprise to modernize using its own resources and dampens social demand for new technology.

2. Because the differences in price between products at the lower and upper ends of the market and between high-quality and shoddy products are minuscule, they do not send a strong enough signal to stimulate innovation.

3. The existence of a seller's market enables enterprises to sell out without making much of an effort.

4. Technology transfer without compensation stifles the drive for technical innovation.

5. That sectors and regions are isolated from one another militates against the mobility of qualified personnel, information, and other vehicles of technology and impedes the conduction of technology.

6. Large numbers of research institutions outside enterprises are out of touch with the latter's production needs.

The above-mentioned aspects have undergone varying degrees of change as a result of reform over the past 2 years. The most crucial change is

the gradual weakening of command planning although it is still dominant in some industries. As long as this condition lasts, the lack of drive for innovation in state-owned enterprises cannot be turned around fundamentally. This is particularly true for enterprises whose products are in short supply on the market. The higher the degree of planning, the greater their tendency to ignore technological progress.

Turning to the relations between government and enterprises, since large enterprises are still under the administration and management of governments at all levels, and because of the present unique economic environment, enterprises under administrative intervention go their own way blatantly. First, enterprises lack the resources, drive, and ability to pursue technological progress. Second, choices in technological investment are still conditional upon government approval of enterprise technical transformation projects. The issue of technological transformation funds and foreign exchange must still go through the higher levels. Third, market demand sends out only feeble signals to stimulate technical progress. On the input side, the enterprise faces an input controller with absolute authority-the government department higher up. On the output side, the enterprise itself can put on a look of absolute authority; market shortages put it in a monopolistic position and free it from dependence on market consumers. On the contrary, it is the market consumer who is totally dependent on the producer's decision. It is simply impossible for the consumer to translate his product wishes into the output of a producer. Nor is he in any position to put pressure on enterprises to modernize or turn out a new generation of products. We call this phenomenon in which enterprises go their own way "enterprise sovereignty under administrative intervention," as opposed to "consumer sovereignty."

From the perspective of government, reform has greatly strengthened the power of local authorities. The division of labor in macroeconomic regulation and control between different levels of government has not been clearly delineated. The foreign trade, finance, and banking systems have yet to be sorted out. The government's economic functions and social management functions have yet to be untangled. Everybody puts his interests first. Under these circumstances, sectoral monopoly and regional fragmentation become unavoidable.

To sum up, enterprises that are still largely subordinate to administrative organizations, competition under soft restraints, and government intervention combining economic functions with macroeconomic management--all this has an unfavorable impact on technological progress and conduction in China, as illustrated below:

Competition: Enterprises compete to import, not to make their own products. Since 1983, when the importing power was delegated, sectors, localities, and enterprises have been vying with one another to import from abroad as long as they have some foreign exchange at their disposal. The import scramble peaked in 1981, resulting in massive duplication among imported goods and setting off wave upon wave of import fever, from television sets to refrigerators and VCR's, from

Western suits to beer to copiers. Competition was most ferocious in products in midstream and downstream industries. Meanwhile, new product trial-manufacturing costs in those industries grew more slowly than their counterparts in upstream industries. Clearly, the short-term benefits of imports are readily obtainable while domestic manufacturing from design to production takes 2 to 3 years at least. This factor alone leads to sharp competition among enterprises as importers but peaceful coexistence as domestic manufacturers. Obviously this state of affairs is a major roadblock to the upgrading of the existing structure.

Monopoly: A monopoly on import leads to duplicated imports. In Japan, duplicated importing succeeded because of the monopoly of and competition between major corporations. In pre-reform China, enterprises did not have a sense of competition since the state monopolized foreign trade and importing and decided even the market shares of production units in the country. After administration was simplified and power delegated, foreign trade policy-making power was fragmented. The fragmentation of policy-making power may be the high road to competition and technological gains. In the absence of institutional guarantees, however, excessive fragmentation can only result in excessive competition at a low level, which causes a low-level monopoly.

State intervention: Simple power delegation led to a loss of control on importing. Administrative simplification and power delegation has changed the old foreign trade system where the state had overall responsibility for all profits and losses. Now the state is responsible only for importing a handful of major commodities impacting the national economy and people's livelihood, large plants, and technical projects. There has been an increase in foreign exchange earnings retained by local authorities and the sectors. Enterprises authorized to engage in foreign trade may import on their own. The delegation of the power to use foreign exchange cannot but be related to rising import duplication; localities with more power to use foreign exchange have a higher incidence of import duplication.

The above analysis shows that the inability of technological progress mechanisms to function normally in China is the basic cause for the stagnation in technological conduction. From the economic perspective, technological progress mechanisms have not been able to function normally because of institutional defects.

3. Fundamental Choices Facing China

China is confronted with a series of choices:

First, should it choose a technological progress model that is demand-led or technology-driven?

In technological progress theory, the "demand-led" model and the "technology-driven" model each have their own proponents. In reality, however, technological progress of the "demand-led" variety may have a

better chance of succeeding. In the U.S., only 5 percent of innovative suggestions come from universities and a few laboratories, while as much as 95 percent of innovative ideas originate with interest groups in business and the corporate world. In Europe, innovative suggestions most likely to pay off come from people in commerce, with a success rate of 55 percent. Thus the World Bank arrived at this important conclusion, "Market feedback is an extremely vital incubator of innovative suggestions." In China, although there has never been any clear-cut theory or model formulation on technological progress, the allocation of the crucial elements of technological progress almost invariably points in the direction of the "technology-driven" model, that is, a model not dependent on the market but on developments in science and technology itself. Research personnel at the first front of production are small in number (only 30 percent,) low in caliber, and poorly-paid and have little research funds, whereas research personnel in research institutions that exist independently of enterprises are plentiful, of a high quality, and well paid and have ample research funds. According to analysis by the State Patent Bureau, patent applications from enterprises accounted for merely 10 percent while non-enterprise patent applications made up 90 percent. Moreover, while invention patent applications accounted for 60 percent, applied patent applications constituted 37 percent. In Japan, the allocation of the key elements of technological progress is exactly the opposite: over 61 percent of research personnel work in enterprises and enterprise research funds accounted for more than 70 percent. If China does not correct its misplaced allocation priorities, we fear that enterprises cannot become the main vehicle of technological progress. Therefore, at a time when scientific research is seriously out of step with production, there is a need to select a new technological progress model. Only by selecting the "demand-led" model can we guarantee the effect of competition in technological conduction. Accordingly, the further introduction of market mechanisms should give enterprises not only proper decision-making power in production, supply, and marketing, but also greater independence in pursuing technological progress and adopting patterns of behavior in long-term development that are consistent with economic logic.

Second, choices in state intervention: compulsory substitution or simple delegation of power?

Under present circumstances, the state cannot simply give away its power to intervene in technological import, technological conduction, and technological progress. But state intervention in technological progress should not be direct participation in the choice of projects. Nor should it control the reallocation of the key elements of technological progress. The key is to create an environment that will face enterprises with choices and promote the circulation of key elements. To create this kind of environment, the state should adopt compulsory substitution policies:
1) compulsory import substitution. Apart from state-of-the-art software, midstream and downstream industries should put an end to the import of hardware. Whatever should be imported has already been

imported (including key parts and components.) Now we should enter the stage of domestic replication and innovation. Parts and components imported for assembly lines which are unavailable at home for the time being and still in need of support by foreign exchange should all be subject to a product tax or value-added tax [VAT]. Equipment, raw materials, and parts that need to be imported for processing or assembling with materials provided should also be subject to a product tax or VAT if they are unfavorable to technological progress or domestic manufacturing. These compulsory import substitution measures should be considered supplementary to the "Provisional Regulations on Certain Policies Promoting Technological Progress in State Enterprises" promulgated by the State Council through the State Economic Commission, the Ministry of Finance, and the People's Bank on 8 February 1985.

2. Compulsory product substitution and compulsory import substitution will break the self-perpetuation and self-maintenance of the internalized structure, while compulsory product substitution will end the self-protection and self-duplication of the existing structure. So-called compulsory product substitution means imposing supply and demand restrictions on obsolete products which, despite poor technical performance, still have a market, and forcing the shift of elements of production to new areas. Supply restriction requires imposing severe penalties on backward producers. We may do so through the levy of a steep progressive tax on enterprises which are inept and complacent during the time when the obsolete product is being eliminated. Apparently, policies are also needed to curb the use of obsolete products as well as their production. This means demand restriction. At the same time, if the trial manufacturing of new products involves too much cumbersome formalities and is under-funded, if the products are under-priced and the tax exemption policy is not really enforced, or if it encounters sectoral blockade or regional protectionism, then the substitution process cannot be completed. In short, compulsory substitution policies will drive enterprises with obsolete technology into a tight spot. And enterprises in a tight spot will be forced to seek a way out through technological progress. The thinking behind compulsory substitution is more favorable to technological conduction than that behind mere administration simplification and power delegation.

Third, choices in organizational format: corporation, departmentalization, or localization?

Besides the introduction of market mechanisms and the effective implementation of state intervention, we need an organizational format that can make the most of economies of scale in order to ensure a smooth course for technological conduction. All over the world today, the incorporation of industrial organizations has become the key to success in international competition. In China's auto industry, embryonic corporations have already appeared but we have yet to put together a corresponding corporate production system. Apart from a few plants that can be counted on the fingers of a hand, such as No 1 and No 2 Auto Plants, the bulk have not achieved economies of scale. To establish a

large-batch production system, the state needs to come up with a complete set of policies to bring about 'corporate reorganization" and urge enterprises to reorganize, merge, and join together through planning, credit,tax, and other means. Corporate reorganization should be the main format for encouraging technological conduction.

Fourth, basic choice: producer sovereignty or consumer sovereignty?

As noted above, under administrative intervention, each enterprise going its own way is a basic barrier in the planning system to technological progress. The drive with which an enterprise pursues technological progress depends on its relationship with the department above. The less involved the relationship and the closer its ties to the market, the more powerful its push for technological progress. This has been proven in practice in recent years. Weakening and ultimately severing its ties with the department above and establishing and then perfecting its linkages with the market, therefore, is a critical piece of reform that will turn the enterprise into a leading player in technological progress.

Clearly, there is no doubt what our choices should be.

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Intensifying Enterprises' Demand for Technology

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[Article by Gu Jiekand [7357 0094 1660], Yuan Puquan [5913 2528 3123], Yun Jing [1926 4552], and Shen Zufang [3088 4371 2455]: "How To Make Enterprises More Desirous of Modern Technology"]

[Text] The marriage between science and technology, on the one hand, and the economy, on the other, requires that scientific and technological structural reform be intensified in order to make scientific research units orient themselves better to economic construction. Even more important, it requires that the drive by factories and enterprises to pursue technology be stepped up. In the final analysis, only factories and enterprises can translate productive forces in the "form of knowledge" into real productive forces. The intensity of their demand for science and technology determines the extent of the integration, vertical and horizontal, between science and the economy. Their ability to absorb and assimilate new technology directly influences the speed of and returns on production development.

The Pursuit Of Technological Progress Should Become The Basic Attribute Of Enterprise Leaders

The quality of an enterprise leader to a large extent dictates whether or not the enterprise has a strong desire for technological progress and its ability to develop production on the strength of technological progress, as demonstrated in these three ways:

First, a strategic vision and a strong enterprising spirit. Only the enterprise leader equipped with a strategic vision in enterprise development, an intense enterprising spirit, and a strong sense of responsibility--"build a first-rate enterprise and turn out first-rate products"--can generate an intense desire for and consciousness of pursuing technological progress, consider technological progress the lifeblood of enterprise development, and make science and technology the tower of strength that the enterprise relies on for its development and the wings for its takeoff. And only such a leader can overlook gains and losses, successes and failures in his own tenure in the interest of the pursuit of technological progress and remain unperturbed by short-

term personal interests and glory and really combine the pursuit of the enterprise's immediate interests with its long-range development.

Second, a pioneering spirit and the courage to take risks. Risk is reaching for and challenging the future. Risk carries with it the seeds of opportunity and success. The brilliance of an outstanding enterprise leader lies not in his ability to "steer" the enterprise through a calm sea, but his ability to identify the direction clearly, set goals, and make correct policies amid ferocious market competition and his ability to open up a new path and achieve success in the middle of competition and risks. The determination and will-power to turn risk into success comes from the stubborn pursuit of technological progress and the long-term interests of the enterprise.

Third, a high level of scientific culture and a strong aptitude for management. To speed up technological progress, an enterprise leader requires a strong aptitude for management and operations as well as a high level of scientific culture. Both are indispensable. An enterprise leader can put his business and managerial acumen to work for the enterprise's technological progress in several ways. In drawing up the enterprise's technological progress plan, he must take into account its economic rationality and post-implementation economic returns as well as its technical sophistication so that the plan will be both scientific and feasible. In implementing the technological progress plan, he must make overall arrangements and organize meticulously to create new productive capacity as soon as possible through the optimal configuration of such elements of production as human, financial, and material resources. As new production capacity is formed, he must work to open up a market for the new product and quickly corner it to make technological progress pay economic dividends for the enterprise without delay. All this demands that the enterprise leader be a good manager. At present, though, many enterprise leaders do not have sufficient managerial business abilities. In the midst of pursuing technological progress, they often consider matters from a purely technical perspective and overlook economic efficiency. This will affect technological progress in its own way.

Establish A System of Scientific Criteria To Evaluate Enterprise Technological Progress

Currently many factories and enterprises are lukewarm in the pursuit of technological progress. Other than the caliber of their leaders, an important reason is that many leading cadres and departments in charge do not take the evaluation of technological progress in enterprises seriously. What limited technological evaluation there is occurs only in passing during the evaluation of economic criteria. What is lacking is a complete set of scientific criteria to evaluate the enterprise's technological progress. Practice over the years proves that evaluation criteria are a "baton" and have an important steering effect on enterprises. Many enterprise leaders pay no attention to technological progress precisely because the higher levels' demand for such progress is a "soft criterion." If our demand for technological progress still

does not go beyond appeals at conferences and the paying of lip service, if we still fail to make it an explicit "hard criterion," then factories and enterprises will not feel a sense of pressure and it will be impossible for leading enterprises in major industries to reach international technical standards of the early 1980's within 10 years. Only by evaluating their technological progress the way we evaluate their economic performance can we enhance enterprises' drive and competitiveness and compel them to shift to new technology and pursue technological progress steadily in their production and operations.

Needless to say, it takes practice, testing, and verification over a considerable period of time to establish a system of scientific evaluation criteria. In our opinion, such a system should include:

First, product grade and quality. An enterprise's technological level ultimately manifests itself in the grade and quality of its products. In this sense, evaluating an enterprise means essentially examining the technical level represented by its products, its market competitiveness and penetration, the proportion of its products that are exported relative to that of other similar products, its ability to develop new products, and product succession cycle, etc.

Second, economic efficiency. Given a specified amount of inputs, the economic efficiency of an enterprise mainly depends on the extent of its technological progress. In evaluating an enterprise's economic efficiency generated by technological progress, we mainly look at the growth rate of its profits and taxes, its profits and taxes as a percentage of its output value, fund, payroll, working capital, and fixed assets, the proportion of the increase in its profits and taxes accounted for by technological progress, and the ratio between increase in profits and taxes after the quality of old products is improved and new products are introduced and total increase in profits and taxes.

Third, the standard of technological equipment. The standard of an enterprise's technical equipment is an important indicator of its technological progress, a basic condition in determining product quality and grade. Evaluation in this aspect involves checking the standard of its equipment relative to that in the industry at home and abroad, whether it is used to full capacity, how long it stays in good condition, the equipment replacement cycle, the progress of technological transformation, and the time it takes to reach advanced domestic and international levels.

Fourth, the educational and technical quality of its workers and employees. To a large extent, technical progress in an enterprise is determined by the presence or otherwise of formidable technological forces and the educational and technical quality of its workers. Here we primarily look at the percentage of scientific and technological personnel, the educational standard of the workers overall, the level of technology the jobs require, after-work classes for workers, technical training, the ability of scientific and technological personnel to research and develop new products, and technical innovative activities

among workers.

Fifth, the level of scientific management. The level of technological progress in an enterprise is also determined by the extent to which enterprise management is scientific and democratic. In evaluating the level of scientific management, we concentrate on the quality of enterprise managerial personnel, the efficiency of systems management, the modernization of managerial tools and methods, and the extent to which management has been democratized.

Once a system of scientific evaluation criteria is in place, we will have a reliable yardstick with which to determine whether an enterprise is really pursuing technological progress, whether it really has momentum, and whether the leaders have real "achievements." In the future, we should make the main criteria for measuring technological progress an important part of the factory director tenure and goal-oriented responsibility system and include it in the contract under the enterprise contracted management responsibility system. That way, technological progress will be directly pegged to the performance, including successes and failures, of the enterprise leader. Only enterprises which boast both good economic performance and fast technological progress can be regarded as an advanced enterprise. Enterprises which do well economically for a while but which do not meet technological progress criteria will not be regarded as such. Nor can their leaders be deemed outstanding entrepreneurs.

Create A Favorable Environment And Conditions For Enterprise Technological Progress

Technological progress in an enterprise is mainly determined by the interplay of a variety of internal factors. However, it is also conditioned by environmental conditions outside the enterprise. For years the traditional economic system and scientific and technological system have suppressed the vitality of enterprises in pursuing technological progress. To speed up technological progress, we must intensify economic, scientific, and technological structural reforms and create a favorable environment for technological progress at the macroeconomic level. Essentially, this means:

First, improve the leadership and management of enterprise technological progress.

For years the leadership and management of enterprise technological progress have been artificially "severed." Science and technology was regarded as an ordinary social matter, the characteristics of the close relation between science and technology and the economy were obliterated, and the economic functions of science and technology were ignored. In the division of labor in leadership, science and technology, on the one hand, and the economy, on the other, were looked after by different comrades. There was not enough coordination between guidance over scientific and technological work and guidance over economic work. Nor was there sufficient communication between different

departments in charge, artificially creating some contradictions which could have been avoided. As we see it, the key to resolving these problems is firmly inculcating the idea of unity between science and technology and the economy among leaders and departments at all levels and seriously tackling technological progress as the crux of enterprise economic development.

Another phenomenon is that while factories and enterprises usually set clear goals and put forward clear demands regarding technological progress and personnel training in their economic development plans, the government routinely separates technical development planning from economic development planning when they formulate the economic and social development plan. Sometimes all technical development gets is a few brief words in the social affairs section. Since technological development planning has not been incorporated into socio-economic development planning, plans drawn up by the science and technology department remain unfulfilled for lack of human, financial, and material resources. On the other hand, enterprise technological progress plans prepared by the economics department do not dovetail with scientific and technological plans, resulting in a mismatch between enterprises' technological needs and the technological offerings of scientific and technological institutions. In drawing up social and economic development plans, therefore, not only must we have strategic goals for economic development, but we must also come up with coordinated goals and demands for technological progress. As part of their respective functions, planning, economics, science and technology, and other departments should help enterprises mesh economic development planning with technology development planning, coordinate them, and put them into effect.

Second, formulate and implement policies designed to encourage enterprises to pursue technological progress.

An important aspect of macro management reform and the overhaul of the functions of state organs to replace direct management with indirect management is to deploy a range of technical and economic policies and apply guided management to enterprises. To speed up technological progress, we must, on the one hand, employ such tools as credit, tax, prices, materials supply, etc., to put pressure on enterprises and compel them to take the technological progress road. On the other hand, we must draw up attractive preferential policies to make enterprises actually feel that it pays to rely on technological progress as they compete on the market and hence consciously pursue technological progress. Current economic policies have two problems. One is that preferential policies designed to induce enterprises to take up technological progress are less than perfect and are not coordinated. Two, there are no policies to punish those enterprises content with the status quo of technical backwardness. Some policies actually end up "whipping the fast cow" and sheltering the laggard.

Third, intensify scientific, technological, and economic legislation and necessary administrative management.

To strengthen macroeconomic control and management, we need to write into law precepts and regulations proved to be effective through practice so that they become a vital driving force of technological progress. At present, the absence of concomitant legislation and administrative rules and regulations on technological progress deprives enterprises of a certain coercive and restraining force. They have little enthusiasm or desire to pursue technological progress. Some enterprises continue to turn out low-grade, even shoddy, products using obsolete equipment and backward technology and still manage to muddle through. This situation severely affects the technological standards and product quality of all enterprises and factories in society. We must enact legislation soon to phase out or modernize outdated products by a certain date, institute a product license system, and adopt national and international production standards. We must promulgate regulations mandating the replacement of obsolete equipment within a set time. We must study and prepare quality standards and economic batch standards for major products. We must investigate cases where shoddy manufacturing leads to serious quality defects and hold the personnel involved legally liable. Reform requires legislation. Legislation, in turn, promotes both reform and production development.

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Two Models for "Spark Plan" Technology-Intensive Zones

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[Article by Cheng Zongyi [4453 1350 7328]: "Create 'Technology-Intensive Zones' To Push 'Spark Plan' to a New High"]

[Text] After the second national "Spark Plan" work conference in 1986 and building on the work of the earlier period, various localities have set up "Spark technology-intensive zones" (abbreviated hereafter as intensive zones.) The creation and development of the intensive zones marks the entry of the implementation of the "Spark Plan" into a new stage and presages solid development in the commercialization, specialization, and intensification of the rural economy. Judging from their developmental history and present state, we can divide the zones into two development models. One is the concentrated intensive zone in which a large number of "Spark Plan" projects are clustered in an administrative area equivalent to the district or county. Most of these projects have become or will become the backbone industries of the local economy. In a concentrated intensive zone, the implementation of the "Spark Plan" has resulted in the integration of the economic and social development of a region. The other model is the diffused intensive zone characterized by the presence of one or two flagship "Spark Plan" projects and a certain number of other related "Spark Plan" projects. These projects are scattered over a relatively extensive administrative region, combining the natural resources of the outlying countryside with the technological superiority of the urban center. Both the concentrated and diffused intensive zones aim at vitalizing the rural economy, but since each has its special features, we need to treat them differently and work out different development strategies.

1. Comparing The Two Models

1) They differ in geographical boundaries and administrative subordination. The concentrated intensive zone has clear geographical boundaries. Not so the diffused intensive zone, where the link between "Spark Plan" projects is industrial.

2) They differ in the reserves and distribution of natural resources. In a concentrated intensive zone, the distribution of natural resources

is more compact. Moreover, the resources are substantial enough to provide the basic condition for long-term development. The diffused intensive zone, on the other hand, boasts abundant natural resources that may last forever and are distributed over a larger geographical area.

3) They differ markedly in the concentration of technology and qualified personnel and methods of their importation. When it is first set up, a concentrated intensive zone lacks technology and qualified personnel. Since it cannot develop if it relies on local technology and expertise, the concentrated intensive zone must import them from outside. A diffused intensive zone, in contrast, abounds in technology and qualified personnel distributed in every social quarter. The question is how to combine them organically into a complete system so that it can serve the zone most effectively.

4) They differ in the location of their markets. The concentrated intensive zone must look outside for its major markets and exports the bulk of its output to foreign countries. Accordingly, it must take transportation and the competitiveness of its products into consideration. The primary market of a diffused intensive zone may lie outside it. Or it may be found within the administrative region in the zone. In light of the "Spark Plan's" development goals, however, both should take pains to cultivate the international market.

2. Different Strategies For the Two Kinds of Intensive Zones

1) Adopting different development strategies

The concentrated intensive zone and the diffused intensive zone have somewhat different developmental goals and labor under slightly different constraints. The objectives of a concentrated intensive zone are consistent with the overall goals of the locality's economic and social development. The two sets of goals may actually be one and the same thing. Under these circumstances, not only does the development of the concentrated intensive zone mesh with local economic development, but it will also spearhead and dominate local economic development. In drawing up a plan and implementing the "Spark Plan," we must fully utilize the intensive-zone format to develop the local economy without, however, being confined by it. We should innovate boldly so that there will be overall unity in the region's social and economic development. Clearly, the diffused intensive zone requires a different development strategy. Here the emphasis should be on the development of strong industries, the marriage of urban technology and qualified personnel with rural natural resources, and the realization of urban-rural integration. What the diffused intensive zone looks for is the best way to merge natural resources with technological resources. Thus an effort must be made to study and analyze the distribution and the qualitative-quantitative relationship of resources and select projects for development carefully. On the basis of its ample marine resources and formidable technological prowess, for instance, the aquatic products intensive zone in Wuhan proposes to develop marine culture and a range

of new technical projects in the machinery, electronic, and chemical industries that are compatible with aquaculture and can help promote its growth.

2) Different technological, qualified personnel policies

The key to developing a concentrated intensive zone is attracting an inflow of technology and qualified personnel. In its early stage, the concentrated intensive zone should "use a variety of flexible methods and disparate channels to attract qualified personnel." For instance, "Sunday engineers" and "summer corps of university students" have appeared everywhere, as has the contracting of engineering and technical personnel. These and other effective methods can be deployed to solve the shortage of qualified personnel. In addition, a locality should be ready to spend money to develop expertise and establish a stable long-term contingent of qualified personnel. The diffused intensive zone enjoys a certain advantage in technology, qualified personnel, and information. Still, this advantage cannot be brought to bear if the resources are not put together. Thus the strategy of the diffused zone is to use economic interests for leverage, put an end to the fragmentation of the old system, mobilize the technological and personnel resources of institutions of higher education, scientific research institutions, and enterprises, and establish a horizontally integrated organization similar to a technology development corporation so that technology and qualified personnel, both required by an intensive zone, are combined into one powerful force for industrial development.

3) Different fund distribution and collection methods.

Since the development of a concentrated intensive zone is integrated into the economic planning of the entire region, funds are pooled and centrally allocated more readily. Although the diffused intensive zone is the focus of development in the larger administrative area, it is more vulnerable to the distractions of regional division as far as fund allocation and distribution are concerned. Usual funding methods do not work as well in its case. Thus a special intensive zone fund should be set up with money from three sources--loans, treasury appropriations, and science and technology funds. The money should be managed and spent in a unified manner by an "intensive zone development fund."

4) Different management methods

Government departments are directly responsible for the management, guidance, and coordination of a concentrated intensive zone. It is up to the state to establish or name a special management body to plan for it centrally and exercise centralized leadership. In a diffused intensive zone, on the other hand, the government should delegate the zone's planning and management entirely to a technology development group after helping set it up. The relations between the member units of the group will essentially be determined and regulated by economic interests.

The creation and development of "Spark Plan" technology-intensive zones is a novelty at a certain stage of the "Spark Plan" in China. A number of new problems may emerge in its implementation in the future, whose solution will require continuous research and exploration on our part. Both models should rely on technological progress to spur the development of productive forces and the commodity economy during the primary stage of socialism. Faced with the reality of fierce competition on the market of the commodity economy and rapidly advancing technology, let us improve the "Spark Plan" continuously and elevate it to a new high.

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Reverse Engineering Said Key To Effective Use of Imported Technology

40080121 Beijing KEYAN GUANLI [SCIENCE MANAGEMENT RESEARCH] in Chinese
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[Article by Yang Aiqun [2799 1947 5028], Institute of International Economic Cooperation, Ministry of Foreign Economic Relations and Trade: "Reverse Engineering of Imported Technology"]

[Text] This article explains what is meant by reverse engineering and several main ways of doing it; it demonstrates the necessity for increasing and widely promoting reverse engineering, and it discusses how to make imported technology Chinese. In addition, it proposes ideas and ways of making greatest use of reverse engineering's optimum technological and economic benefits.

1. What Is Meant by "Reverse Engineering"?

By so-called reverse engineering is meant the complete, systematic and penetrating scientific analysis of imported technology obtained from international technology transfers for the purpose of studying in reverse its functioning, structure, component raw and processed materials, design, manufacture, utilization efficiency, and conditions in which it is used, as well as other relevant factors of importance, with the goal of using and developing the technology effectively. In a broad sense, imported technology generally includes imports of hardware that embodies technology such as advanced equipment, spare parts, and new materials, as well as imports of technical data that do not embody technology such as design drawings, and information about materials, technical standards, testing data, manufacturing technology, specialized personnel, scientific and technical information, and scientific administration and management methods. Thus, the objects of study in reverse engineering include both hardware and software.

Reverse engineering contrasts with the usual straight use of imported technology in the fields of production or consumption. It requires that people "buy hens to lay eggs, and buy eggs to hatch hens" in the importation of technology, which is to say that it requires people to assimilate, digest and innovate pervasively with regard to imported technology in order both to use it effectively and to gradually fully understand and develop it for the purpose of forming our own technical system, hastening the pace

of making it Chinese, and finally gaining optimum technical and economic benefits from it. Clearly, the study of reverse engineering can enable people not only to understand how imported technology work, but why it works.

There are numerous specific means of reverse engineering; however, the ways most commonly used internationally at the present time are just the following ones:

1. Transplants. By this is meant that once imported technology or equipment has been reverse engineered, its mysteries revealed and its design and manufacture understood, this information is applied in a directed way to other products.

2. Synthesis. By this is meant the reverse engineering of large numbers of technologies or equipment of the same kinds, conducting a complete analysis, comparing strengths and weaknesses, making use of advantages and detouring around disadvantages, matching up completely, and concentrating in a single product the superior points of similar items made by different manufacturers to produce a higher level technology or piece of equipment.

3. Partial Revamping. By this is meant reverse engineering of imported technology or equipment to find some places having defects and finding ways to improve them.

4. Complete Revamping. By this is meant the reverse engineering of imported technology or equipment in order to decide whether the imported technology or equipment is suitable for China and to what extent, given natural resources and conditions under which the technology and equipment would be used in China. If it is completely unsuitable to conditions in China, a complete revamping if undertaken. Generally speaking, complete revamping applies to technical data (such as technical standards, design drawings, technological documents, control information, scientific and technical information, and specialized personnel), i.e., to reverse engineer the technical data for the imported technology. The reason that complete revamping is usually done by reverse engineering of the technical data is that this requires a smaller expenditure and produces greater technical and economic benefits than reverse engineering of the hardware.

5. Extension. By this is meant building on the technical achievements of predecessors in the reverse engineering of imported technology or equipment in an effort to extend applications by finding new technical fields or fields of use, seeking development and improvement in the process of continuing.

6. Seeking Optimum Benefits. By this is meant creatively transplanting, synthesizing, revamping, and extending imported technology or equipment, as well as using it in creative ways in order to gain optimum technical and economic benefits.

With the implementation of a policy of opening toward the outside world in recent years, the scale of China's current technology imports is second only to that of Japan for second place in the world. How to take fullest advantage of such large scale imports of foreign technology to derive optimum technical and economic benefits is an urgent and important task facing us. For this reason, we must increase and widely promote the reverse engineering of imported technology.

2. Ideas and Methodology for China's Development of Reverse Engineering. China's large scale importation of technology began in 1979 and has continued to the present time. In fact, more than 10 billion dollars of foreign exchange was used for the importation of more than 10,000 items of technology at the level of the late 1970's and the early 1980's. This technology played an inestimably positive role in the modernization of China. Statistics from the State Planning Commission show that during the Sixth 5-Year Plan, China signed contracts with foreign countries for the importation of 1,300 different large and medium size technological imports on which $9.7 billion of foreign exchange was spent. The imported technology related to energy development, communications, raw and processed materials industries, and electromechanical industries, with technical data accounting for 50 percent of the total. Some of the technology filled domestic voids. Examples were the importation of 300,000 and 600,000 kilowatt generating units, 500,000 volt direct current and alternating current electrical transmission and transformer equipment, programmable telephone exchanges, satellite earth station equipment manufacturing technology, and manufacturing technology for large plate slab continuous casting machinery. Increased production capacity resulting directly from the imported technology included: an installed electricity generating capacity of 2.06 million kilowatts, 7 million tons of select raw coal, 3 million tons of steel, 3.05 million tons of cement, 2.27 million tons of urea, 80,000 tons of electrolytic aluminum, 3.82 million standard cases of plate glass, and 3 million square meters of synthetic leather. As a result of benefits attributable to imported technology such as numerically controlled machine tools, large harvesting combines, 500,000 volt alternating current electricity transmission and transformer equipment, complete 10 million ton class open pit mining equipment, and 100,000 ton class marine diesel engines, China is now substantially able to rely on domestic manufacture for this equipment.

Use of imported technology and the readjustment of existing domestic enterprises are strategic actions for the tapping of enterprises' production potential in China and for spurring economic growth. They are also important ways of promoting technical transformation and technical progress in enterprises. Statistics from the State Economic Commission show that during the last 3 years of the Sixth 5-Year Plan (1983 through 1985), the State Economic Commission was responsible for organizing the importation of 3,900 new technologies for use in the technical transformation of existing enterprises at a cost in foreign exchange of $3.6 billion. This imported technology was for the use of more than 20 industries in the industrial, business, and agriculture sectors. Once applied, they had a direct effect in increasing productivity, in giving impetus to the

technical transformation of enterprises, in hastening the technical progress of enterprises, and in enabling China to produce goods. As a result, the technical level of some of China's industries and some of its products rose tremendously for a great narrowing of the technical gap with developed countries. During the Sixth 5-Year Plan, 200,000 technologically transformed items went into production in state-owned enterprises, and fixed assets worth 110 billion yuan was newly added. More than 60 percent of the new industrial output value gained during this period derived from technological progress, and it was mostly this technological progress that made possible the importation of technology. For example, the imported advanced textile technology has enabled a succession of principle enterprises to reach advanced industrial standards in spinning, weaving, and dyeing processes. Thanks to imported technology, the percentage of products throughout the machinery and electronics industries meeting the international technical standards of the 1970's and 1980's rose from 15 to 35 percent. Imported technology has improved the structure of China's exports, a number of electromechanical export products having been added. In addition, imported technology has increased from 30 to 60 percent the items manufactured in China on ships exported by China's shipbuilding industry.

Imported technology has also enabled the development and strengthening during the past several years of the country's high technology research and newly developed technology. As a result of technology imports, we have equipped 20 key, unrestricted laboratories at the national level, and 30 top flight key scientific research laboratories (including laboratories for genetic engineering, enzyme engineering, new materials elements, marine engineering, and resources and environmental information).

In short, in both macro and micro terms, the overall situation in the importation of technology during the past several years has been good and the results achieved have been very outstanding. This does not mean, however, that there are no problems in the importation of technology. Take reverse engineering, for example, to which China is not yet paying sufficiently serious attention. There have been numerous general calls for the digestion, assimilation, innovation and improvement of imported technology, but very little has actually been done. The pace has been too slow in making such technology Chinese; consequently, it has not been possible to make fullest use of the optimum technological and economic benefits of imported technology. This shows up specifically in the following ways: First, some sectors and units import technology simply in order to use it without developing it further. As soon as technology has been updated, the existing advanced technology is termed antiquated goods. This devolves into a vicious cycle of import, use, and import again. Second, once some sectors and units import technology, they hog it for their exclusive use. This engenders further imports, which has led in recent years to calls to "put on the brakes," but no halt to repeated imports. Third, some departments and units that need to import only certain key equipment bring in a complete production line without regard for the huge expenditure required, even though the production line could be produced through reverse engineering. All these various problems await study and actions to make genuine changes.

Ours is a country having scant accumulated wealth and a large population in which the ability to digest and absorb technology and management is fairly low. Consequently, the development of reverse engineering will face numerous limitations. Thus, we will have to make active efforts to emulate advanced international levels, analyze and compare methods of reverse engineering used by other nations in the world, particularly our main competitors in the Asia and Pacific region, and spell out the objectives and direction of our own efforts. We will also have to work from China's actual capabilities to digest and assimilate imported technology, formulating research and implementation plans that are consistent with the current economic and technological situation in China. Serious attention and strengthening of methods of conducting research on reverse engineering research must be done if China's reverse engineering is to proceed smoothly and result in fairly good technological and economic benefits.

On the basis of positive and negative experiences of both China and foreign countries, the following may be envisioned as ways of conducting reverse engineering in China today:

1. Further Perfection and Strengthening of the Technology Import Control System; Improvement and Strengthening of National Macromanagement and Macrocontrol of All Importation of Technology. The importation of technology is an extremely complex job that ramifies into politics, economics, scientific research, production, law, economics and trade, commercial inspection, and customs. Currently some shortcomings exist in China's economic control system that get in the way of the importation of technology. National ministries and commissions concerned function to control the importation of technology. Their separate functional responsibilities are not very well spelled out, however, and various problems exist in control, including not very close coordination between higher and lower levels, numerous levels, onerous procedures, and low efficiency. These problems show up in units that import technology not being attuned to the needs of units that use technology, units that use technology and units that do technical research not being attuned to each others needs, and units that import technology and units that do technical research not being attuned to each others needs. As an important element in the importance of technology, reverse engineering is also inhibited by these shortcomings. Smooth development of technology imports and their reverse engineering requires reform of the existing technology import control system, as well as the building of a centralized control organization with the authority to coordinate relationships among all sectors concerned. Such a control organization can effect macromanagement and control in the following ways over the reverse engineering of technology imports. First is organization of the collection of pertinent information inside and outside China, legislation pertaining to technology imports, studying and formulating national plans and policies, establishing clear cut technology import procedures, and gradually transferring to enterprise, to entreprenural banks and to consulting and evaluating units both the risks and the benefits to be derived from the importation of technology. This would go a long way toward overcoming the lack of foresight on the part of local and national

level enterprises in investing in the importation of technology, and toward strengthening awareness when investing that they are responsible for their own profits and losses, and for their own digestion and blending into production of the imported technology. Second is research and formulation of national plans for technology imports and their reverse engineering, making this a part of national economic development plans for the whole country, while simultaneously formulating specific regulations for implementation in an effort to follow through and succeed in eveyr case. Third is to centralize the examination and approval, and the registration of large imports that affect the overall situation. Examination and approval of items to be imported within quota should be entrusted to departments and industries concerned, and overall direction and control over industries should be strengthened so as to avoid speaking to the outside world through several mouths and duplicating imports. Fourth is breaking of the fetters on national and local coordination, centrally coordinating the forces of all units engaged in importation, use and scientific research in the carrying out of important reverse engineering. Fifth is the formulation of a table showing prohibited imports and high tariff imports based on Chinese and foreign circumstances at any given time, so as to make sure that normal production and scientific research activities in China will share a fair competitive environment with the importation of technology. Sixth is use of multiple administrative, economic, legal, and information control methods for the full promotion of valuable results obtained from reverse engineering. All areas and sections can set up necessary technology import control organizations as their own situations warrant to help the central government carry out the work, controlling level by level, moving together in a single direction, and giving impetus to the reverse engineering of their own technology imports.

2. Establishment of a Policy of Imports for Technological Development and Technological Progress. The experience in development of numerous countries shows that importation of advanced foreign technology is a shortcut for spurring domestic technological progress. However, use of imported technology to strengthen one's own self-development capabilities and to rapidly spur technological progress is founded on the digestion and assimilation of imported technology. Therefore, in our importation of technology, it is necessary to establish a policy of importing for the purpose of technological development and technological progress, and to give serious attention to the reverse engineering of technology imports, thereby making imported technology Chinese. Three changes should be made as quickly as possible with regard to the importation of technology, as follows: First is to change from importing most production lines and complete plants or sets of equipment to the importation of mostly technical data and critically needed equipment. Second is a change from mostly importation by individual enterprises to mostly joint importation by industrial, trade and technical organizations. Third is a change from mostly use in production to mostly digestion and assimilations. China is still in the stage of vigorous development, and the shortage of foreign exchange will continue for some time. This poses an objective requirement for the use of limited foreign exchange in the most critical places. Realization of the aforementioned "three changes" will require both insuring that a wide field at a high

level be provided for reverse engineering, and that expenditures for the importation of technology be greatly reduced. In today's international technology transfer market, one time expenditures for the importation of most hardware are usually higher than for the importation of corresponding technical data. In addition, after hardware has been imported, usually more foreign exchange has to be spent for the purchase of foreign spare parts. Therefore, to import only hardware without importing the corresponding technical data is economically not worthwhile. Blindly desiring to import just hardware is bound to make us become perpetually a large market for dumping "foreign goods."

3. Better Verification of the Feasibility of Deriving Economic Benefits From the Technology To Be Imported. This is actually an investment decision about the riskiness of the technology to be imported. Obviously, the higher the degree of feasibility, the smaller the investment risk. In making a technical feasibility ferification of the technology to be imported, a complete, systematic, and penetrating scientific analysis will have to be made about the technical superiority, the technical suitability, the competitiveness, and the life expectancy of the technology to be imported, as well as prospects for its development. When the technology is selected, it will be necessary to try to select fairly advanced contemporary technology, and consider whether the imported technology can be creatively developed and prospects for doing so. It will also be necessary to pay attention to actual objective conditions both in China and abroad and not set off blindly in pursuit of the most advanced and the most sophisticated technology in the world. This is because the supplier of such technology usually wants a high price for it or else it is not available for transfer. Furthermore, China's ability to assimilate and digest such technology is limited. Excessive importation of such technology is bound to create a waste of import money, and it will be difficult to assimilate and digest it well all at once. The correct way of doing things is to work from the economic and technological situation prevailing in China to establish, on a foundation of national strength and national circumstances, rational technical standards for a certain level of advanced technology that can be used to verify the feasibility of using the technology to be imported. Concretely speaking, verification must proceed from the country's technological foundation, its ability to provide associated technology, and its ability to assimilate and digest the technology. In addition, special attention should also be given to verifying how well the imported technology meets enterprises' operating objectives, their operating strategy, their product development, and their upgrading and updating of products. The possible compatibility of the imported technology with technological conditions in China has to be analyzed, as well as the possibility of improving technical conditions in China to correspond with the imported technology, or readjusting the imported technology so it will correspond with technical conditions in China.

In the course of verifying the economic feasibility of the technology to be imported, evaluations of financial feasibility and economic benefits should be made. Financial feasibility should be verified in terms of foreign exchange repayment ability, the time limit on repayment, the return on investment, and the matching and balancing of funds within the country.

Economic benefit is really a reflection of the final result of all technology import work. The size of the economic benefit is decided by every link in the importation of technology. Usually, it is only after a project has gone into production that a final evaluation can be made. For some projects having long range social benefits, it may take many years after the project has gone into production before the outcome can be seen. This does not mean, however, that it is not possible to make forecasts and analytical verification of the economic benefits obtainable from imported technology. In fact, such forecasts and analytical verifications can be made, and are very necessary. Right now, we particularly have to figure out the correlation between partial benefits and complete benefits, and between short term benefits and long term benefits, correcting the erroneous method of using only partial benefits or short term benefits as criteria for making decisive evaluations. Verifications have to be a combination of qualitative analysis and quantitative analysis.

4. Organizational Method for Making Importation, Use, Development, and Transformation Into "a Coordinated Process." We must apply the principles of systems engineering to the inherent relationship between technology imports and use, technical development, and technical transformation, using products as the "turnkey" for linking together organically the several links of imported technology, use of technology, development of technology, and transformation of technology, making centralized deployments and taking coordinated action so that they will be in complete harmony and complement each other. At the same time, integrated plans for reverse engineering should be systematically carried out on the several levels of complete machines, spare parts, components, and primary and supplementary materials. This method of organization has the advantage of being very synchronized and highly efficient. Once success has been scored, it is possible to begin series commodity production very quickly, thereby gaining better technical benefits and avoiding having the results of research halt at the "sample," "display item," or "gift item" stage, and long delays in going into commodily production.

5. Institution of Responsibility Systems. Units in charge must be established in every deparment and industry with responsibility for reverse engineering projects on every important piece of imported technology, and these units should be responsible for setting up corresponding project coordination groups for the widespread launching of lateral liaison among multiple disciplines, multiple techniques, multiple technologies, and multiple sources of raw materials. Each unit responsible for reverse engineering should designate a person responsible for the project, sign economic agreements, and carry out inspections as progress is made on plans. In addition, competition may be introduced step-by-step, reverse engineering projects can be transferred from administrative points to preferential sites for which tenders have been invited, and those engaged in the reverse engineering can be put under economic and technical contracts, thereby organically linking their responsibilities, authority, and benefits.

6. Creation of Necessary Conditions. This applies primarily to the following three matters: First is improvement in relevant testing, calculating, and analytical methods. "When a workman wants to do good work, he must first sharpen his tools." Reverse engineering of imported technology requires mastery first of certain advanced material techniques. Doing this requires that simultaneous with the importation of foreign technology, some testing, calculating, and analyzing devices and tools used for reverse engineering, and which are in short supply in China, must be imported at the same time. We must have a strategic thought of casting bricks to attract jade in return. Second is the establishment and perfection of relevant information networks. Success in reverse engineering is founded on success in importing technology, and success in importing technology, in turn, is inseparable from gaining accurate information. If we import antiquated technology thinking that it is advanced technology, and then set about reverse engineering it, of what value is that! There are modern patents on more than 30 million pieces of technology in the world, and the number increases by more than 1 million each year. Using the international method for dividing up patents, patents may be divided into 55,000 groups, a colossal number. Numerous developed countries devote extraordinarily serious attention to information about patents contained in technical references. The USSR, for example has as many as 1.5 million employees (both directly and indirectly employed) engaged in this work. In an international environment in which the amount of information is increasing daily, how can we sit idly by? Third is gradual solution to the problem of a source of research funds. The reason for Japan's very great success in digesting, assimilating, and creating with regard to imported technology is directly related to the extraordinarily serious attention given to reverse engineering. During the period after the war when Japan imported technology on a large scale, for every $1 worth of technology, an average of between $3 and $5 more was spent on digesting and developing it. At the present time, the tendency in China's plans for investment in technology imports is to emphasize importation but slight digestion and assimilation. Effective action should be taken at once to adjust and correct this situation. The role of the state, local governments, and enterprises must be brought into play to solve the problem of funds for the reverse engineering of imported technology.

To summarize the foregoing, by giving serious attention to and strengthening the reverse engineering of foreign technology, a benign cycle of "importing technology, digesting and assimilating it, expanding exports, and importing more high level technology" can be realized in China's importation of technology.

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Survey of Mobility Among S&T Personnel Summarized

40080107 Tianjin KEXUEXUE YU KEXUE JISHU GUANLI [SCIENCE OF SCIENCE AND MANAGEMENT OF S&T] in Chinese No 1, 1988 pp 34-36

[Article by Wan Li [8001 0500]: "Report on the Mobility of Scientific and Technical Personnel Throughout China--the Analytical Results of a Survey of the Mobility of S&T Personnel Throughout China in R&D Organizations, Institutes of Higher Learning, and Medium-to-Large Scale Enterprises"]

[Text] Bureau of Scientists and Technicians, State Scientific and Technological Commission

In order to do a quantitative analysis of the tendencies and consequences of recent mobility among scientists and technicians, in June 1987 this Bureau conducted a survey of the mobility situation between 1 January 1984 and 1 June 1987 as it applied to scientists and technicians (hereafter, S&T personnel) of at least a secondary vocational school education or who had a specialized technology and who worked in R&D organizations, institutes of higher learning, or medium-to-large scale enterprises. This survey sampled 1,444 units, or 10.34 percent of the total number of units working within the three systems just named. We distributed 1,444 survey forms and received 1,250 in return. Of those, 1,158 were valid, or 80 percent of the total distributed. The main results may be summarized as follows:

I. Trends in Mobility

The overall trend in the mobility of skilled personnel is closely related to the general climate of governmental policy and restructuring in recent years. It may be seen from the survey that beginning in 1984 the mobility of S&T personnel began to increase, that it peaked in 1985, that it dropped abruptly in 1986, and that in 1987 it began to rise again. The following explanation can be made: after the promulgation of the resolutions by the Central Committee and the State Council regarding the restructuring of the economic system, the restructuring of the science and technology system, and the restructuring of the educational system, with the intensification of each restructuring plan, with the development of the socialist commodity economy and the rise in the degree of the commercialization of S&T achievements, with the challenge to the system of excessive control over S&T personnel, and with the stimulus of a series of policies to encourage S&T personnel to make more contributions, there appeared the favorable trend in which the mobility

of skilled personnel focused on S&T personnel. By 1985, after the Central Committee produced the resolution on the restructuring of the science and technology system, this momentum toward mobility on the part of S&T personnel peaked. In 1986, because the various policies for the motivation of S&T personnel were not coordinated, because management was not consistent, and even because there were inappropriate objections and restrictions within society toward the "mobility," there was a dramatic drop in the number of S&T personnel experiencing mobility. But from the last half of 1986 through the first half of 1987, under the stimulus of a series of favorable principles and policies on the rational mobility of skilled personal, such as "Some Provisions Regarding Further Advancement of the Restructuring of the Science and Technology System" from the State Council, there occurred once more a rise in the trend of S&T personnel ability. This shows the function of policies as guides, and also shows that the potential energy in the mobility of S&T personnel is yet to be released. This tendency is even clearer within R&D organizations.

1. After 1986, there was a tendency for mobility among S&T personnel in institutes of higher learning to drop (see table 1).

2. Looking at moblity among S&T personnel by region, it can be seen that there was a renewed rise in mobility trends in coastal and interior regions after 1986, while this dropped in the frontier areas after 1985 (see table 2).

II. The Quantities Involved in Mobility

Between 1 January 1984 and 1 June 1987, there was an influx of 226,000 people into the three systems and an outflow of 314,000 people, for a total loss of 88,000. Among these people, there was an influx of 44,000 into the R&D organizations and an outflow of 61,000 people, for a total loss of 17,000 people; 41,500 people went into the institutes of higher learning and 37,100 left, for a total gain of 4,400 people; 140,700 people went into the medium-to-large scale enterprises, while 215,600 left, for a total loss of 74,900 people.

1. Losses of S&T personnel in the medium-to-large enterprises were serious. During the three and one-half years, 215,600 people left the medium-to-large scale enterprises, which was 68 percent of the number of people lost to these three systems (314,800). The situation regarding the excessive losses of people within the medium-to-large scale enterprises is worth our attention.

2. The rate of mobility among S&T personnel has been low. Looking at the figures from the point of view of the rate of mobility among S&T personnel (i.e., the number of personnel in transition as a percentage of the total number of S&T personnel), for 1984 the rate of mobility for S&T personnel within the three systems was 2.70 percent. This was 2.76 percent in 1985, 1.90 percent in 1986, and 2.01 percent in 1987. The average rate of mobility for the period 1984-1987 was 2.02 percent, which is quite different from the 20 percent of the United States and the 17 percent of the USSR.

3. The rate of mobility among S&T personnel within the R&D organizations was higher (see table 3). This shows that the R&D organizations are more open to the idea of greater latitude for S&T personnel.

III. Directions of Mobility

Currently, the ratio of S&T personnel who move between provinces as opposed to those who move within a province is 4:6. It can be seen from the general trends of the mobility of S&T personnel that the primary trend is to go from west to east, and to move up rather than down, i.e., S&T personnel are moving from frontier areas or from economically undeveloped areas to more economically developed provincial capitals and to more economically developed areas; they are moving from within frontier provinces and regions to interrior and coastal developed regions; and they are moving from units at base level enterprises to units within administrative organizations and public agencies.

1. There has been a serious loss of S&T personnel from the frontier regions. The balance of the influx and outflow of S&T personnel within the frontier areas has two characteristics: first, for years the outflow has been greater than the influx. Second, the number lost has been higher than in the coastal and interior areas.

2. Within the three systems, the mobility among S&T personnel is unbalanced. The losses of enterprise S&T personnel to mobility is counter to the direction advocated by the reforms: 52 percent of S&T personnel are working in public agencies outside of the institutes of higher learning and the research institutes; this is especially true for those S&T personnel moving to public agencies from enterprises, 76.42 percent of whom go to this sort of unit. Of S&T personnel who move into enterprises, 51.77 percent work in enterprises that are non-manufacturing. Of those leaving the institutes of higher learning, 81.72 percent are also working in non-manufacturing enteprises.

3. Large numbers of S&T personnel are moving toward administrative organizations. The number of S&T personnel in the three systems moving into administrative organizations is greater than the number in administrative organizations moving into the three systems (see Chart 1), which is counter to the direction advocated in the reforms.

4. The number of S&T personnel moving into collectives and individual units after 1986 has been rising. This shows that the relevant documents from the State Council have had a positive effect, and have stimulated a group of courageous and knowledgeable S&T personnel to get rid of their iron rice bowls and to contract to run collectives, town and township enterprises, and start-up civilian science and technology organizations.

5. The ratio of S&T personnel in the coastal regions moving into collective and private units is larger than for other areas. There are more within the coastal regions, and the interior ranks next, while there is a great gap within the frontier regions. To a certain degree, this reflects the progress of the greater opennes due to the restructuring.

IV. The Modes of Mobility

1. The primary mode at present by which S&T personnel evidence mobility is still via the single administrative transfer. Only 2 percent do so by keeping their positions but forfeiting their salaries, or by resigning (see table 4).

2. It can be seen from the changes in the figures for keeping position but forfeiting salaries and for resigning that the greatest number of those resigning came in 1985, that there was an abrupt drop in 1986, and that there was a recovery in 1987. There has been a rising trend for the number of those who keep positions but forfeit salary.

3. Looking at the systems, there are more people resigning within the medium-to-large enterprises, while those doing so within the institutes of higher learning are fewest. The trends in changes are compatible with the overall trend for S&T personnel to resignations.

4. Looking at regions, more S&T personnel have resigned within the coastal regions, fewer inland, and fewest within the frontier regions.

5. Looking at the composition of those S&T personnel who resign, we can see that most of the people resigning are S&T personnel at aid-level positions or lower. Only in the coastal regions have a minority of high ranking S&T personnel resigned. To a certain degree this shows that there are differences in the work stability of S&T personnel at different levels.

V. Factors in Mobility

1. Currently, the stimulus for S&T personnel in China to request transfers is still to resolve needs in their lives or to escape from environmental pressures. According to the analysis of the survey statistics, during the period 1984-1987 the various factors involved in the mobility of S&T personnel break down in the following ratios: 29 percent were to resolve difficulties within the family (including improving living conditions and wages); 20 percent were for resolving the problem where the husband and wife each work in different areas, while the proportions for moving to take employment elsewhere, movement because employment was not commensurate with abilities, and movement to improve working conditions stood at 2, 3, and 9 percents, respectively.

2. Viewed in terms of professional positions, among those S&T personnel seeking transfer due to difficulties within the home, 68 percent were entry level and not yet assigned to work, and 31 percent were at mid-level positions. Looking at ages, the majority were young or middle-aged.

Conclusions

We can see from the results of this survey that with the steady intensification of reforms in China's economic system, governmental system, and science and technology system, the management of our S&T personnel has begun to

relax, which has produced some good trends. But basically speaking, there has been no fundamental change in the situation whereby freedom of movement is impeded, where management can be stifling, and where allocation is not in accordance with need. This is an important problem that must be resolved by the further restructuring.

Table 1. Trends in the Mobility of S&T Personnel (in the category of institutes of higher learning)

unit: individuals

	1984	1985	1986	1987 (Jan-May)
Major Institutions	2,858	3,128	2,668	1,011
Non-Major Institutions	6,808	7,644	5,624	2,004
Vocational Schools	1,796	1,538	1,494	621

Table 2. Trends in the Mobility of S&T Personnel (by region)

unit: individuals

	1984	1985	1986	1987 (Jan-May)
Coastal Region	36,800	37,201	27,154	13,088
Interior	38,857	44,533	30,884	14,412
Frontier	23,092	23,495	18,436	6,844

Table 3. The Proportions of S&T Personnel Mobile Among the Three Systems

unit: individuals

Sector	Number of People Mobile	Proportion
R&D Organizations	61,971	2.8%
Institutes of Higher Learning	37,197	1.8%
Medium-to-Large enterprises	215,631	1.0%

Chart 1. Directions of Mobility Among S&T Personnel

Administrative	-- to 11,071 3,782 to --	R&D organizations
	-- to 5,454 2,144 to --	Institues of Higher Learning
Organizations	-- to 10,180 6,094 to --	Enterprise Units

Table 4. Modes of Mobility Among S&T Personnel (by Region)

unit: individuals

	Leaving	Keeping Position While Forfeiting Salary	Resigning	Other
1984				
Coastal	96,078	78	942	1,649
Interior	88,157	54	195	449
Frontier	22,552	0	93	445
1985				
Coastal	99,990	103	2,751	2,448
Interior	42,747	40	917	828
Frontier	22,624	18	411	508
1986				
Coastal	72,918	220	1,141	2,225
Interior	29,623	23	211	1,025
Frontier	17,697	71	355	342
1987 (Jan-Jun)				
Coastal	32,303	174	426	692
Interior	13,857	125	145	284
Frontier	6,649	29	157	68

12586/7310

Attracting Top-Flight Talent To Open Laboratories

40080138 Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 1, 1988 pp 44-48

[Article by Hu Gengshen [5170 1649 3947], Wuhan Physics Institute, Chinese Academy of Sciences: "Preliminary Views on How To Attract Domestic and Foreign Scientists To Open Laboratories"]

[Text] This article uses Chinese Academy of Sciences open laboratories as examples in posing the problem of how to attract domestic and foreign scientists to open laboratories in general. It also offers eight points that should be emphasized to attract them as follows: emphasis on publicity that shows scientific research capabilities; emphasis on talent for the development of top-flight personnel; emphasis on accomplishments and the proper selection of main targets for attack; emphasis on equipment and complete technical systems; emphasis on distinguishing features and making the most of individual strengths; emphasis on exchanges and the expansion of contacts; emphasis on pay and emoluments, and improvement of logistical services; and emphasis on leadership for better management of science.

The Chinese Academy of Sciences has selected some laboratories and institutes having fairly high academic standing and fairly good equipment that are to be opened to both Chinese and foreign scientists. (Nineteen of them have already been formally opened). More laboratories and institutes will continue to be opened in the future to spur research work in the fields of basic and applied research for the gradual building of a new open, fluid, and cooperative system oriented toward world competition. This is an important reform measure taken by the Academy to make better use of the potential that existing scientific research forces and equipment hold, and it should both enliven work of a fundamental nature on basic and applied research, and produce continuous and steady development. It will open channels for linking together research work inside and outside the Academy; it will provide places at which exchanges on domestic and foreign academic thinking and of scientific and technical personnel can be conducted; and it will provide brand new laboratory research bases for the development of China's scientific and technological endeavors. Open research laboratories meet needs in the burgeoning development of modern science and technology, and they are a new thing that has sprung up in reform of the scientific research system.

However, whenever something new first appears, various problems and stumbling blocks are bound to be encountered, and it is difficult to avoid the difficulties and complications that accompany its growth and development. Right now the problem of how open laboratories can bring about a new situation and how they can attract outstanding scientists from inside China and abroad to take part in laboratory work is a real problem meriting serious attention. Unless this problem is solved, open laboratories may become a dead letter. Since there is no successful past experience in China that can be turned to for guidance, it will be difficult for a time to provide definite and well-considered answers to this problem. The writer believes that the eight points explained below should be given serious attention, thereby enabling work at open laboratories to bring about a new situation rapidly, and to make them attractive to both Chinese and foreign scientists.

1. Emphasis on Publicity That Shows Scientific Research Capabilities

So-called "open research laboratories," as the name suggests, means the opening of laboratory doors in an orientation toward Chinese and foreign experts in the same fields. Thus, the first step should be to inform those to whom the opening of laboratories is directed about all the ins and outs. This is the only way that people can decide, on the basis of their own specific situations, whether they should go to these places to work and conduct research.

There are numerous ways to inform people, briefings and publicity being the main one. This includes both oral and written publicity and briefings. Although the Academy's opening of laboratories has been formally announced, not many people are really well informed about the details and the main scientific research capabilities of the laboratories and schools. Though the experts and professors who took part in the discussion and assessment of the laboratories are fairly well informed, only a very limited number of people and units have information. There is still a very long way to go before those in the same fields (particularly in foreign countries) are generally informed. Therefore, in order to change the situation rapidly and attract the widespread participation in the work of these laboratories of outstanding Chinese and foreign scientists, briefings and publicity must be provided that contain the right kind of information and that have been prepared in the proper form.

The briefings and publicity might contain information about the leaders and researchers in the main fields of study at the open laboratories, available scientific equipment, number of technical personnel, services provided, the work environment, current research interests, and information about future main objectives and research topics, etc. Particular stress should be given to the major academic accomplishments of academic leaders and renowned scientists, and the laboratories' major scientific research achievements, as well as information about the training of graduate students and the status of scientific research management. At the same time, details should be provided about specific procedures for the processing of applications, etc.

The form and methods of briefings and publicity may be many and varied. For example, encouragement and support (including needed funds support) might be given for the publication in international academic journals of articles by laboratory scientists. This would be for the purpose of informing others, particularly those in foreign countries, that China's open laboratories have begun academic exchanges as one important means of building a feeling of confidence. 2. Organization of small study groups that can be visited, and exhibitions of scientific research achievements. This is an effective method used by scientists both in China and abroad for building influence, and for showing off accumulated academic knowledge and research achievements. 3. Making a start in editing and publishing Chinese and foreign language briefings about specific laboratories, or shooting short motion picture films on specific laboratories. 4. It is suggested that KEXUE BAO [SCIENCE JOURNAL] carry columns such as "Open Laboratories" to provide information continuously about open laboratories, and that articles be published about topics such as laboratory management. 5. Editing and publishing under the name of the Academy and central government ministries for sale both in China and abroad of "The Chinese Academy of Sciences First Group of Open Laboratories," etc. All of these are specific actions that are both realistic, feasible, and effective.

It should be emphasized that briefings and publicity have to be based on facts, allow for unforeseen circumstances, be positive and well founded, and aim at achieving results. In particular, when setting forth scientific achievements, measures speech and scrupulous avoidance of wild exaggeration should be emphasized; otherwise the outcome will be just the reverse of the intended one.

2. Emphasis on Talent for the Development of Top-Flight Personnel

The key element in scientific research capabilities is human talent. With talent, the country can be run well and security and peace assured. Only when talent is available is accomplishment possible. If a scientific research organization possesses a number of talented people who stand out from the others, naturally that will hold tremendous attraction for the scientific world internationally. Therefore, a good job of operating laboratories so that they will attract both Chinese and foreign scientists entails emphasis on talented people, particular attention being paid to top-notch young talent and to the training and use of academic leaders who are fairly well known.

Comrade Deng Xiaoping said, "Several thousand top-notch people should be chosen from the science and technology system. Once these people have been selected, facilities should be provided that enable them to devote themselves wholeheartedly to research work." (See "Selected Works of Deng Xiaoping," pp 37-38). The laboratories that the Academy of Sciences has selected are the research entities having a relatively high academic standing. If China is to begin to shoulder the task of orienting toward world competition, it will have to give more thought to the talent issue and take actions to ensure that all necessary conditions are in being to enable these research

entities to do a better job of producing results and talent so that outstanding scientific research talent can come to the fore. Efforts should be made to increase the "name recognition" of scientists who are truly outstanding, who are outside the general run, and who have made major accomplishments no matter their age or length of service, thereby enabling them to establish a reputation as authorities and to rank among the world's noted people so that outstanding scientists "radiate splendor throughout China's scientific world and cover with glory the billion inhabitants of the divine land of China." This will not only be helpful to the open laboratories, but is also necessary for the development of China's scientific and technical endeavors.

Two things should be stressed with regard to the talent for the Academy's open laboratories. First, active efforts should be made throughout China and the whole world to spot and invite ranking guest researchers to come to them. Second, the existing pool of scientific and technical talent has to be relied upon, presently available scientists and technicians becoming engaged in a further widespread search for talent, actively nurturing talent, making sensible use of talent, and actively employing all kinds of talend to best advantage. Special emphasis should be placed on nurturing and selecting superior young scientists, and to identifying and bringing to notice top-notch personnel and academic leaders, open laboratories thereby becoming scientific research communities that have leaders possessed of high academic credentials and top-notch talent.

3. Emphasis on Accomplishments and the Proper Selection of Main Targets for Attack

It is numerous and fine accomplishments that convince and attract both Chinese and foreign scientists. Bell Laboratories in the United States is the world's largest communications research unit. Since its founding more than 50 years ago, it has received more than 17,000 patents, has made more than 50 major scientific research achievements, and has won three Nobel prizes. It enjoys a very high reputation in the international scientific world. As a result, it has attracted scientif and technical personnel from all over the United States and foreign countries to work there, including quite a few well known experts and professors. Clearly, it is talented people who produce achievements, and achievements that attract talented personnel. This is generally true of renowned scientific research organizations.

As applied to the Academy's open laboratories, what can be done to produce achievements and do first rate work in a fairly short period of time? The writer believes that the key lies in selection of the main direction of attack. The purpose of open laboratories being the performance of high caliber research work, selection of the main direction of attack should be done along the two following lines: First is to aim at international standards, making a mark by discovering some breakthrough on the leading edge of a specialized field. Second is to focus on domestic needs, finding a topic that has fairly widespread applications in the research field, and then putting emphasis on it. As to just what

international standards each laboratory should aim at and what domestic needs they should focus on, that will naturally depend on the academic committees of the laboratories concerned doing some study of their own, making judgments, and decisions. This article cannot do this work for them. However, the aforementioned two main directions of attack should be clear and beyond doubt. This is because for open laboratories to be open to both Chinese and foreign scientists, they have to meet domestic standards, and be a "national deputation;" they will have to engage in international competition, so they will have to be of "high grade." At the same time, science and technology has to serve in building the economy; therefore, it is hoped that these high level research corps will produce important practical results, and major contributions that are directly applicable to development of the national economy. These two main directions of attack will be decided by the goals and the quality of the open research laboratories.

If the Academy's open research laboratories can use their existing research as a foundation for proper selection of the main direction of attack, organize forces to tackle critical problems, and achieve some results at advanced domestic and international levels within a short period of time, their positions will be greatly enhanced. Those who produce results will stand firm in China and be unassailable internationally. When that time comes, one can just imagine the attraction for scientists at home and abroad.

4. Emphasis on Equipment and Complete Technical Systems

"A workman who wants to do good work must sharpen his tools first." This is true in doing a job or in fighting a battle, and it is also true of scientific research. Moreover, as science and technology advance to a higher level, scientific research depends to a greater extent on complex precision instruments and equipment. Contemporary scientific research at a high level and of great difficulty cannot be done without the necessary apparatus and equipment.

The necessity for "tools" is obvious and generally receives serious attention. But what is to be done about "sharpening" the "tools," and how they are to be maintained, used, improved, and replaced so that they can be fully effective is a question that people frequently ignore. As soon as some comrades get fine apparatus and equipment in their hands, it seems everything is just fine, but delay after delay is encountered in providing the technical personnel to go with the apparatus. One frequently sees the following situation in scientific research: In one research laboratory, work does not move along, while another laboratory equipped with identical apparatus and equipment and having identical experience succeeds easily. This shows that even if advanced apparatus and equipment is available, in the absence of skilled technicians, and without a highly skilled technical service corps that understands how equipment functions and has a thorough knowledge of the "spirit" of the apparatus, high level research work cannot be done.

The apparatus and equipment and the technicians in the Academy's open laboratories today are beginning to take shape; however, there is still a long way to go in terms of satisfying the scientific research needs of society, and attracting Chinese and foreign scientists to do high level research work. Success in this will require the purchase of additional apparatus and the replacement of equipment as quickly as possible, while completing the staffing of technical personnel and improving management standards at the same time. This is the only way to meed needs in opening laboratories to Chinese and foreign scientists. The limitations on China's national strength at the present time, and the considerable gap with developed countries in the level of China's science and technology causes substantial difficulties for work in this regard. However, if our guiding thought is correct, if we do not go in for grandiose projects, if we select a proper direction on the basis of the work we are performing now, act within our capabilities, and struggle arduosly, we will succeed in the end, making the laboratories better and better. For example, the Bopu Laboratory (an open laboratory) in the Academy's Wuhan Institute of Physics, did a good job of pushing ahead with and accomodating some specific experiments, thanks to its highly skilled technicians. As a result, within less than 3 years time, more than 100 scientific research units and universities in 25 different provinces, municipalities, and autonomous regions from all over China came to the laboratory to do tests on more than 3,000 samples using a single 200 mega [sic] nuclear magnetospectrograph. For China, such advanced apparatus and equipment and the technical staff to go with it is second to none, hence the strong attraction.

5. Emphasis on Distinguishing Features and Making the Most of Individual Strengths

In demonstrating scientific research capabilities as in preparing top-flight talent, and in choosing the right direction for a main attack as in equipping a technical system, "national circumstances and national strength," "the Academy's circumstances and the Academy's strength," and "a laboratory's circumstances and a laboratory's strength" have to be considered. Distinguishing features have to be emphasized, and the most made of individual strengths. This is because distinguishing features and strengths hold attraction and are the source of success.

Reportedly, a large number of foreign scientists would like to come to China to do research, and the subject they are most interested in is medicine, especially Chinese traditional medicine and herbal remedies. The reason is that China originated Chinese medicine. We have it and they do not, or we had it first and they got it later. Chinese medicine has a long history in China, and it has accomplished much. Foreign countries are now far behind us. We hold an advantage and distinguishing features in this regard. Clearly, an advantage is itself a strength, and advantages hold attraction.

Every country, every unit, and every person has individual advantages, and eacj can build individual distinguishing features. The crucial issues are: 1. To understand oneself and find advantages; 2. to analyze oneself and define ones distinguishing features; and 3. to make the most of ones

advantages and to develop ones distinguishing features. This is the way to success. China's female contingent in a famous international athletics completition critiqued each of its performances, made a better showing each time, and won victory after victory to capture the "pentathalon championship." The important secret of such a tremendous success is emphasis on distinguishing features (such as quick attack and coordination of agreed upon actions), making the most of advantages, and playing up strengths while playing down weaknesses. The experiences of the female contingent should be studied in running the open laboratories well.

The evaluation and approval accorded the Academy's first group of open research laboratories by experts, professors, and scholars in the same field demonstrates that these laboratories possess, in varying degrees, considerable advantages and certain distinguishing features. Unfortunately, some of the advantages are fairly slight at the moment, and some of the distinguishing features are not very evident. They cannot yet serve to represent the country's standing in carrying out a foreign exchange program, and they are not yet sufficiently attractive to Chinese and foreign scientists. This means that those concerned with the open laboratories will have to organize forces, draw on their collective wisdom and absorb all useful ideas, diligently analyze and study, find advantages and make the most of advantages. They will have to identify distinctive features and developed these distinctive features. Only by so doing will it be possible for these laboratories to achieve a leading position in China and ultimately achieve a standing in the international world of science.

6. Emphasis on Exchanges and Expansion of Contacts

The history of the development of science shows that contacts and cooperation among scientists and technical experts has been important both to the research work that the scientists and technical experts themselves were engaged in, but also to the development of all scientific endeavors. An open research laboratory will naturally have to forge links with both Chinese and foreign scientists, and increase exchanges with the outside world. This is an effective way of finding and attracting outstanding talent in all fields. For example, in order to continuously attract outstanding research personnel, the famed American Bell Laboratories organizes a special group to conduct inquiries at all famous universities to find out about highly talented students whom they then organize to tour their laboratories. They organize such a campaign six or more times each year. At the "Science Park" in the suburbs of Oxford and Cambridge in the United Kingdom, a thick roster of names is available in which is recorded information about the academic background, published works, special skills, and even the hobbies, disposition, and temperament of electronics experts. These are geared to the needs of society, and they identify human talent. I believe that although the situation in China is véry different from that in foreign countries; nevertheless, this method of widespread social contact, know what is available, and attracting talented personnel is something we might usefully borrow.

The Academy has initiated numerous kinds of foreign contacts in recent years, such as fact-finding visits, advanced studies, cooperative research, guest lecturers, participation in academic conferences, etc. We already

have some understanding of specialized fields in China and abroad, and the principle figures in them; however, this information should be further broadened and deepened to meet new circumstances and new needs. Inasmuch as open laboratories are oriented toward both China and foreign countries, insofar as conditions and circumstances permit, active efforts should be made to forge links with scientific research organizations of interest in China and abroad, with institutions of higher education, with industrial and mining enterprises, with academic bodies, with academic associations and societies, and with international organizations for the purpose of making contacts. These widespread links and contacts should be used for the selection of outstanding talent. In addition, these links and contacts, and particularly the links and contacts made with important Chinese and foreign scientists in recent years, should be summarized, classified, and collated, with files being set up on foreign contacts that record their names, the organizations in which they work, their professional specialties, their professional accomplishments, the research they are presently doing, papers they have published, etc. Advantages that may be gained from open laboratories emphasizing foreign links and making contacts with domestic and foreign scientists may be capsulized as follows:

a. Helps in the exchange of knowledge among scientists, widens intellectual horizons, serves as a channel for the communication of information, diversifies thinking methods, places people in an information environment that is in the forefront of their field of study, and promotes new scientific research achievements.

b. Helps attract Chinese and foreign scientists to conduct joint research, which helps in the direct spotting, selection, and hiring of guest research personnel who are able to travel, particularly high level experts and scholars.

c. Helps link scientific research to businesses and industries to solve the problem of expanding investment.

7. Emphasis on Pay and Emoluments and Improvements of Logistical Services

Emphasis on pay and emoluments and improvement of logistical services is also an important factor in attracting both Chinese and foreign scientists. The first step in this work is the earliest possible decision about pertinent questions such as fair remuneration, subsidies, and bonuses to be given guest researchers by the open laboratories, providing them with preferential pay and emoluments by way of demonstrating sincerity in welcoming them to the laboratories to do joint work. Guest researchers coming to work at laboratories may bring with them new academic thinking, and desirable knowledge and information. They may also bring a reputation and influence with them. This is a form of talent and knowledge importation for which the payment of a somewhat higher price is worthwhile. In addition, since these are institutes open to the outside world, every effort should be made, insofar as requirements and capabilities permit, to improve the various logistical services facilities and to pay attention to beautification of the research achievement, making full material preparations for receiving high level Chinese and foreign experts, scholars, and other research personnel.

8. Emphasis on Leadership for Better Management of Science

The key to implementation of the above points lies in leadership, and the key to success or failure in the work of the laboratories lies in management. Emphasis on leadership and better management is the most basic way of insuring that the Academy's open laboratories achieve success. The rapid development of the General Electric Company's research institute in the United States during the early period after its founding serves as a good example of the great power of scientific management. This institute was founded in 1900, Professor Willis R. Whitney of the Massachusetts Institute of Technology serving concurrently as its first organizer. After coming to the institute, he made rules permitting researchers at the institute the following four freedoms: 1. Freedom of research; 2. freedom of choice of research methods; 3. freedom of information exchange; and 4. freedom of publish results. This was a major pioneering effort at the time to break restraints that had come down from the 19th century on the publication of papers by young scientists, and it greatly helped in enlivening the academic atmosphere, and in encouraging, and in selecting outstanding talent. Subsequently, he worked through a talent network, getting first Professor William D. Coolidge and then Professor Irving Langmuir to come to the institute. Under the superb leadership of Whitney, within the short space of just several years both Coolidge and Langmuir demonstrated astounding creative capabilities. They invented the tungsten filament alectric light bulb, the electric tube, and the X-ray tube, as well as the use of inert gas in incandescent light bulbs to prolong bulb life, creating great wealth for the General Electric Company. Both Coolidge and Langmuir went on to become the most creative scientists in modern history. This shows that success or failure of a research organization is determined, to a large extent, by its leadership and management. However, it is in this regard that the Academy, like other scientific research organizations throughout China, is weak. Therefore, great efforts must be made to assemble top-flight personnel to devote serious attention to the improvement of research.

The "Provisional Management Methods for Chinese Academy of Sciences Open Laboratories" provide that that open laboratories institute examination and evaluation by an academic committee, and establish a director responsibility system. It also provides that the director of the academic committee may serve concurrently as director of the laboratory. This insures that the laboratory director will be a key player among the leadership nucleus; therefore, how to select laboratory directors becomes an important issue that must be urgently explored. In the writer's humble view, the laboratory director should be a scientist, though not necessarily a scientist with the most outstanding academic accomplishments. Even more important, he should be adept in scientific management. As the laboratory's helmsman and person in charge, he should be enthusiastic about building up the laboratory, devote himself to producing people of talent, produce accomplishments, and struggle relentlessly to achieve the scientific research goals of the entire laboratory. Naturally, a capable and vigorous assistant is indispensable to the laboratory director for the highly efficient management of matters such as plans, equipment, administration, external matters, information, accomplishments, and personnel. Outstanding leaders, scientific management, and highly timely work is bound to promote production of talent and results, as well as development of the laboratory.

The above eight points may be stated in a nutshell as manpower plus management. These eight points are mutually related, mutually reinforcing, and are mutually cause and effect. They are very inclusive. Though some have to do with problems that have just arisen, if serious attention is given to them now, the work of the Academy's open laboratories can get underway rapidly, making their attraction for Chinese and foreign scientists greater and greater. Our open laboratories will then be able to become gradually open research laboratory bases that are distinctively Chinese.

09432/7310

Shanghai S&T Structure Undergoing Major Changes

40080104b Shanghai JIEFANG RIBAO in Chinese 6 Mar 88 p 1

[Article by correspondent Li Wenqi [2621 2429 4388]: "Structure of Shanghai Science and Technology Organization Undergoes Five Major Changes; Scientific Research Structure Melds With Business To Promote Service to the Shanghai Economy; a Group of Scientific Research Institutes Enters Business or Business Groups To Varying Degrees"]

[Text] New changes are underway in the midst of reform of the organizational structure of the Shanghai science and technology system as follows: Research organizations are beginning to meld with businesses, entering businesses or business groups in varying degrees to promote service to the Shanghai economy. A few days ago, the director of the Shanghai Municipal Science Committee, Jin Zhuqing [6855 2691 7230], briefed the correspondent about the heartening changes in this regard.

Change Number 1: Scientific Research Organizations Are Melding With Businesses in Various Ways

Statistics show that 43 scientific research organizations have entered businesses or business groups in Shanghai, 13 of them inseparably.

Each of these institutes has entered business in a different way. Some dissolved to enter; some became members of labor and trade integrated entrepreneurial companies; and some entered newly created business groups following disbandment as companies administratively. Their technical development funds come mostly from businesses or business groups to suit the needs of businesses or business groups.

Another 31 Shanghai scientific research organizations have entered business or business groups in a loose way, and some institutes have entered two or more businesses at the same time. This loose form of cooperation has been fairly well received by both the research units and businesses.

Change Number 2: Scientific Research Organizations Have Become Technical Development Centers for Industries

A Municipal Science Committee survey shows that 37 scientific research units in Shanghai tentatively plan on developing into technical development centers for industry. Their function would be as follows: To carry on technical development for industry, solve industry's common technical problems, take part in industry's technical assimilation, be responsible for providing industry with information, standards, and inspections and for training personnel, and spurring technical progress in industry. Some of these research units have conducted pilot projects for may years, scoring remarkable social and economic benefits. Reportedly, an additional 24 research institutes are in process of actively setting the stage to become technical development centers for industry at an early date.

Change Number 3: Scientific Research Organizations Themselves Developing Into Scientific Production (Vanguard) Enterprises

A survey of 89 technical development research organizations shows that some units have a certain ability to meet standards and are able to sustain themselves economically. More than 80 percent of their cash income comes from production that meets standards. Some research institutes have developed into scientific research and production type enterprises. The Shanghai Steel and Iron Research Institute has adhered to a course of integrated production that meets standards. Its scientific achievements have been numerous, and it has paid profits and taxes to the state amounting to nearly 600 million yuan, which is 8.5 times the amount of investment n fixed assets for the whole institute.

Change No 4: Formation of Complete Technical Project Contracting Companies by Scientific Research Organizations and Design Engineering Units

Today Shanghai has 41 complete technical engineering contracting companies formed by scientific research organizations and design units. Most of these companies were founded since 1985 to satisfy social needs, to strengthen complementary capabilities in research, design, and construction, and to promote the application to production as quickly as possible of new technology, new skills, and new equipment. During the past several years, most of these companies have attained anticipated objectives.

Change No 5: Scientific Research Organization Orientation Toward Medium and Small Enterprises, and Toward Township and Town Enterprises, Instituting Various Forms of Lateral Links

Scientific research units have established wide-ranging cooperative relationships with medium and small enterprises, and with township and town enterprises, some of them becoming their technical development departments. Currently, the following several forms are in use: Formation and establishment of new scientific research and production partnerships, both parties investing, both parties operating, and profits being shared on the basis of stock participation; joint operation of specific projects with

enterprises, economic benefits being divided between both parties after the enterprise has gone into production; research institutes and enterprises establishing a set cooperative relationship, the enterprise serving as a base for the research institute to work at meeting standards, the enterprise formally going into production once standards have been met for products.

09432/06662

OPEN ZONE FOR S&T RESEARCH

40100023a Beijing CHINA DAILY in English 30 Mar 88 p 1

[Text] China's first open science and technology experimental zone will be set up in Beijing next month, China Daily learned today.

The Beijing municipal government has finished drafting a series of rules offering preferential treatment to the city's high-tech enterprises in a bid to promote scientific research.

Based on the successful experience of the Zhongguancun Electronics Street in Beijing's Haidian District, an open science and technology experimental zone will be established in Beijing after the rules are approved by the Law Bureau under the State Council, an official from the State Science and Technology Commission (SSTC) said.

The regulation was submitted to Song Jian, head of the commission on Monday and won his consent. Now the Beijing Municipal Government is waiting for approval from the State Council.

The approval of the rules is just a matter of time though some minor changes will be made after input from departments concerned, said the official, adding that the implementation and detailed arrangements for the zone will be decided on entirely by the Beijing government, which has already been entrusted to do so by the State Council.

On Monday, in talks with businessmen from the United States, Song said that the government will encourage and support professionals who run enterprises, under various forms of ownership, in this new experimental zone.

These enterprises can be privately-run or funded from abroad, he said. Enterprises will not have to pay income tax during their first three years of production. The tax will be 50 per cent of the normal rate during the next three years, and then levied at a rate of 15 per cent of total income from the seventh year on.

Imports of some raw materials and exports of certain high-tech products will be duty free, he added.

/9274

NO CHANGE IN POLICY FOR OVERSEAS STUDENTS

40100020 Beijing CHINA DAILY in English 7 April 88 p 4

[Text] "Sending students to study abroad is China's long-standing policy which remains unchanged and will never change," stressed Huang Xinbai in an interview in Beijing on Tuesday.

Huang, a full-time member of China's State Education Commission, is in charge of the work for sending Chinese students abroad.

He quoted reports from some foreign correspondents: "China plans a drastic reduction in the number of its students abroad, especially those in the United States," to 20 percent of the total number of Chinese students overseas, ...that would mean a maximum of 600 new Chinese students arriving in the United States each year," "Beijing has set a new, lower cap of 3,000 a year on the number of students it will finance abroad," and so on.

In a word, Huang said, they tried to tell their readers that China's policy on sending students abroad "has changed."

Huang pointed out that these reports were groundless. Some were based on hearsay, and others were fabricated with ulterior motives.

With the approval of the State Council, Huang said, the State Education Commission publicized a regulation entitled "Some Temporary Provisions for Sending People to Study Abroad" on 11 June, 1987. "There is no change in the principles set forth in the regulation," he added.

China has provided three means for students to go abroad to study, Huang said, namely, through government channels, with the help of the institution of department in which the student works, and through self-sponsorships. Since 1980, the annual number of students sent to several dozens of countries by the government has averaged around 3,000. This year's figure is expected to be roughly the same.

A rapid increase has been registered in the number of students sent by institutions or departments in the past few years. In 1987, the number of such students went up to some 5,000. This year, the figure is expected to remain the same.

Neither the central government nor the State Education Commission controls or, for that matter, knows that exact number of self-financed students going abroad. Their number has been estimated at a minimum of 3,000 per year.

Of all the students studying abroad including the state-funded and self-financed, those going to the United States have accounted for the majority. The same is also true for this year.

Huang disclosed that some 4,600 students will be sent to the United States this year, of whom 600 are state-funded and 4,000 are financed by various institutions and departments. This figure is about the same as that for last year. As for the self-financed students to the United States, the policies will remain unchanged.

Obviously, Huang said, it is utterly groundless to say that the number of students to be sent abroad, particularly those sent to the United States, shall be cut substantially, and still less true to make claims about a "new policy" for those students.

"We decide on the number of students to be sent abroad according to our needs, and by ensuring that what they learn can be applied to the development of our country," Huang said, adding that, "at the same time, we should make sure the students to be sent are qualified." He also stressed that China should send students to different countries to study their strong points.

Huang said, "In the light of our internal situation, it is only normal to make necessary adjustments in our policy for the State-funded students studying abroad in order to meet the demands of our modernization drive."

According to Huang, these adjustments fall into three categories:

--Adjustment of the choices of subjects the students shall study--more students are encouraged to major in applied fields of study.

--Adjustment in the categories of students sent abroad--as China is much more capable in training undergraduate and graduate students. It will not, generally speaking, send students abroad to study undergraduate courses, and will reduce the number of students studying abroad for masters degrees. At the same time, it will send abroad more people who will pursue advanced studies and visiting scholars (including those who have received a Ph.D. in China or abroad). These are applicable to all state-financed students and regardless of the country of study.

--Adjustments in the choice of countries--based on China's needs, it shall send some more students to those countries which are capable of accepting more Chinese students but have taken very few so far.

Huang said that a large number of students concentrated in one or two countries is not a good thing, even viewed from the interests of the students themselves.

For example, Huang said, in some foreign schools there are so many Chinese students that it is hardly possible for them to see their advisors. How can they study well under such circumstances?

Huang recalled that in the past 9 years since China started its reforms and opening policy, the country has sent more than 40,000 state-funded students to study in at least 70 foreign countries and regions. Up to now, 20,000 have finished their studies and returned home.

China has sent student abroad in a planned way and according to the urgent needs of rejuvenating the Chinese nation. This is a reasonable course of action for any sovereign state, he added.

It is the students' unshirkable duty and responsibility to come back on schedule to serve the country when they have finished their studies," Huang went on. This also echoes a common desire of a majority of the Chinese students studying abroad. The governments in many developed countries have also expressed their understanding of this position and have also expressed their understanding of this position and have cooperated with China in this respect.

Huang said it is necessary to set a time limit for state-financed graduate students in their pursuit of a degree in foreign countries.

However, he pointed out, that should not be regarded as a mere limitation. "It means, first of all, that during the absence of the students, the institution or department has funded them has to make such arrangements as to find other employees to fill their vacancies and collect extra funds arising therefrom. In that sense, setting a time limit for those state-funded students abroad is both a guarantee and an urge. It will urge them to finish their studies within a scheduled time," Huang said.

Such limitations, of course, will not be applied to the self-funded students, he added.

The actual amount of time involved in the limit was set in accordance with the schedules of school systems in various countries and with the experiences of former students, Huang said.

Taking university graduates who study in the United States for a doctorate over a 5-year period as an example, Huang said, "such a time-frame is formulated according to the U.S. educational system and the experiences of a majority of Chinese graduates who have finished their studies there in recent years and after soliciting opinions from many Chinese and American experts."

As to the students who have sufficient reasons for extended study periods, they may send their application and get approval from the relevant institutions, Huang said.

Practice shows that the majority of Chinese students studying abroad can finish their studies in the set period, he noted. A recent sample survey of 100

students in the United States showed that 76 obtained their doctorate degrees in 5 years and 22 in 5 to 6 years.

Huang noted that based on experiences in a good number of countries, post-doctorate research is not strictly considered as an academic degree.

Such pursuit is beneficial to some fields of science in China, he said, adding that China supports it provided it is reasonable and meets the needs of the state and of the institution or department that sends people abroad.

The Chinese students who are conducting such research in the United States, Huang went on, are growing larger in number than their American counterparts.

A few students recently issued an open letter saying that the time limit governing post-doctorate research is not reasonable, he said.

Huang said that the letter may have been written without having a full understanding of the situation or without knowing the truth. Huang said that such action is improper.

It is understandable, he said, for the Chinese students studying abroad to have various considerations in designing their development. "But," he said, "I hope they would consider this by putting the interest of the nation first, and trying to combine the two."

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Shanghai S&T Facing Challenges, Actions Proposed

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[Article by Xiao Guangen [5618 7070 2704]: "Shanghai Accelerates the Melding of Science and Technology With Production; Faces Serious Challenge in Loss of Dominance in Science and Technology; Forms Powerful Pool of Intellect To Operate a Number of Scientific and Technical Entities in Order To Strengthen Competitiveness in Exports"]

[Text] Deputy Mayor Liu Zhenyuan [0491 2183 0337], who is responsible for science and technology work in Shanghai, told the reporter several days ago that Shanghai's dominance in science and technology is facing an extremely serious challenge. He was worried that unless Shanghai's science and technical strength could provide full support to the development of an outward looking economy, it would be in danger of losing its dominance.

The challenge comes mostly from fraternal coastal provinces and cities. Following the national science and technology work conference, the State Science and Technology Commission decided to organize a large scientific and technical contingent of 200,000 to help coastal areas carry out a development strategy. The National Defense Science, Technology, and Industry Commission was also prepared to permit scientific and technical personnel on the "three fronts" who had been conserving their strength and storing their energy for a long time would take the initiative in going to coastal areas to make preparations to set up partnerships that combined scientific research with production. This would be a crack group attracted to any place having preferential policies and offering ample scope for their abilities. Shanghai saw that this large contingent would be concentrated in the area around Shanghai, producing powerful competition.

Faced with a new situation of developing an outward looking economy, some people say figuratively that Shanghai is putting to sea in a row boat carrying a life ring; it will have to brave very great risks. A survey of eight industrial bureaus in Shanghai shows most of their equipment to be of prior to 1960 vintage.

Yet another problem that Shanghai faces is that internally its science and technology have not been effectively melded with the economy. For reasons

having to do with the system, concepts, and policies, some of the things that Shanghai was first to propose or first to do were either not done well or not done at all because of numerous limitations, resulting in the loss of numerous opportunities. For example, though the first skills bank in the country was born in Shanghai, today there is less flow of skilled people in Shanghai than elsewhere; though the technology market first appeared in Shanghai, the technology market in places like Shenyang is much more prosperous today than in Shanghai; and though civilian operated scientific research began in Shanghai a long time ago, influential scientific and technical entities have yet to make an appearance in Shanghai.

Early in 1988, Comrade Zhao Ziyang said in Shanghai that the key lies in melding science and technology with industry, and that this script must be followed every day with the same attention given to markets and prices. Unless this script is followed, Shanghai cannot be dominant. Events so far this year show that only science and technology have been relied upon to follow this script for melding science and technology with production, the economic sector not yet doing a good job of it. It can be effective only if government financial organs and foreign trade units follow it. Following discussions and consultations, the municipal government and units concerned either have taken action or are in the process of taking action to accelerate the melding of science and technology with production to support implementation of the coastal strategy. These actions are as follows:

Adoption of different policies to spur science and technology to meld with large and medium size businesses, and with township and town enterprises to produce competitive exports, and a liberalization of policies to encourage and guide organically flexible small enterprises and township and town enterprises, beginning with a liberalization of both foreign exchange retention and payment of taxes on bonuses by those who have earned them. For large and medium size enterprises that have yet to be enlivened, mostly methods of a command nature have been used to hand down research, development, and production tasks for hot selling products, scientific research units being asked to cooperate in tackling problems.

Founding of the Shanghai Science Academy, thereby consolidating the 86 research institutes of central government ministries and commissions in Shanghai to form a powerful pool of intellect and an entity for science and technology development. Continuation of large engineering projects, and good performance in turnkey projects to provide Shanghai with complete technical facilities.

Operation of a number of scientific and technical entities in which research, designing, production, marketing and services are performed in one continuous sequence, plus research institute operation of enterprises to enable science and technology to phase into the economy. In addition, there has been trial operation of technology import companies in which technology, labor, and trade form an integrated whole, various scientific research units playing the main role.

Establishment of the 5 square kilometer Caohejing high technology industrial area.

Founding of the Shanghai Scientific and Technical Investment Trust Company to raise science and technology finance capital through many channels, and to use limited science and technology funds well and flexibly.

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New Technology Zone Slated for Xi'an

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[Report by Liu Rongqing [0491 2837 1987]: "Xi'an To Build a New Technological Development Zone"]

[Text] Xi'an, 17 Apr (ZHONGGUO XINWEN SHE)--In an interview with this reporter today, Xi'an Mayor Yuan Zhengzhong said that a new technological development zone would be built on both eastern and western sides of the old city wall.

This means that a market-directed economy which aims at assimilating advanced technology from abroad and other parts of the country, and at introducing competition mechanisms will be developed in Xi'an, a large industrial city in northwest China. This is a feasible way to prosperity.

Xi'an is a knowledge-intensive city, where the number of scientific and technical personnel in universities, scientific research institutes and large industrial enterprises for national defense is second only to Beijing and Shanghai. However, the closed scientific and technological structure has made it difficult to develop macroeconomics there, letting a large number of people lie idle. A sample survey has shown that only 30 percent of scientific and technological personnel in the city are able to display their abilities, while township and town enterprises and neighborhood undertakings in many cities and counties are extremely short of scientific and technological personnel.

It is Professor Jiang Xinzhen, a newly appointed vice mayor of the city specially in charge of scientific and technological work, who has contributed the idea of building a new technological development zone on both sides of the old city wall. His idea has been supported by State Councilor Song Jian and his colleagues.

After the emergence of the Zhongguancun electronics street in Haidian District of Beijing, there will appear a new technological development zone to be built on the eastern and western sides of the old city wall in Xi'an. The eastern side will be based on Xi'an Jiaotong University, Shaanxi Machine-Building Institute, Xibei Textile Institute and many scientific and technological research offices, and the western side will be based on Xibei

Polytechnical University, Xi'an University of Electronics Technology, as well as the Xidian Company and the Qixing Electronics Group, which are separated from the state plans.

Many private and government-run scientific and technological research institutes which have been established or are going to be set up will cooperate with industrial, agricultural, trade, service and banking enterprises to become economic entities marked by the principle of "collecting funds by themselves, merging at will, assuming sole responsibility for profits and losses, and managing independently."

At a scientific and technological work conference held recently in Xi'an, specialists, professors, entrepreneurs and officials engaged in astronautics industry, aviation industry, ordnance industry, electronics industry and machine-building industry discussed details for building the technological development zone.

In accordance with what Zhao Ziyang has said "lift controls over the scientific field by reducing taxes and assuring more profits," Xi'an city has established rules and regulations for promoting technological development in enterprises and increasing their capability of assimilating scientific and technological achievements, supporting the development of enterprises stamped with high and advanced technology, encouraging part-time jobs and rational movement of professionals and technical personnel, and developing private scientific research offices.

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